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AN INVESTIGATION OF THE NEARSHORE REGION OF LAKE ONTARIO
IFYGL

by

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State University College
Buffalo, New York 14222

GRANT 800701

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FOREWORD

Our nation's freshwaters are vital for all animals and plants, yet our diverse uses of water---for recreation, food, energy, transportation, and industry---physically and chemically alter lakes, rivers, and streams. Such alterations threaten terrestrial organisms, as well as those living in water. The Environmental Research Laboratory in Duluth, Minnesota develops methods, conducts laboratory and field studies, and extrapolates research findings

--to determine how physical and chemical pollution affects aquatic life

--to assess the effects of ecosystems on pollutants

--to predict effects of pollutants on large lakes through use of models

--to measure bioaccumulation of pollutants in aquatic organisms that are consumed by other animals, including man

This report provides insight into the effects of pollutants on the nearshore ecosystem of Lake Ontario. Studies were conducted to determine the quality of the nearshore ecosystem, as well as the movement of pollutants from river discharges.

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Duluth, Minnesota

ABSTRACT

Sufficient quantitative and qualitative information concerning water and sediment chemistry, phytoplankton, zooplankton and benthos in addition to a limited number of physical parameters between April 1972 and May 1973 was collected to establish an environmental baseline for the Welland Canal - Rochester nearshore zone. This information could be of value in evaluating future ecological changes in the aquatic region as well as in the construction of water intakes, beaches, power generating plants and other shoreline projects. The study area could generally be characterized as oligotrophic to mesotrophic. The lowest quality conditions were observed at the Genesee and Niagara River mouths. The thermal bar functioned as a barrier which kept the more nutrient enriched water on the shoreward side of the bar. *Cladophora* growth appeared to be limited by suitable substrate for attachment and the extent of wave action rather than chemical factors. The physical nature of the sediment also appeared to be of major importance in determining which benthos were found in which regions of the study area. Twelve (12) and one (1) previously unreported zooplankton and phytoplankton species, respectively for Lake Ontario were collected during the study. Several changes were observed in the nutrient content of the sediments. Higher concentrations of nutrients, volatile solids and heavy metals were noted in sediments with a higher clay content. Tropical Storm Agnes had little impact on the study region with the exception of the Genesee River mouth.

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SECTION I

INTRODUCTION

The objectives of the U.S. Environmental Protection Agency (EPA) sponsored multi-year project, which is part of the International Field Year on the Great Lakes (IFYGL) are as follows:

a. To ascertain the nature, extent and interactions of inputs, including pollutants, on the aquatic biological and chemical processes in the nearshore region of Lake Ontario.

b. To evaluate the rate of flow of nutrients into, out of, and within the study area, including movements between aquatic and benthic habitats.

c. To examine the role, if any, of a thermal bar on nutrient transport and recycling, as well as a biological barrier.

d. To develop an ecological baseline that could be of value in the evaluation of the impact of proposed developments (i.e., sewage treatment plants, electric power generating stations, etc.) along the Lake Ontario shoreline and tributaries, as well as in the eutrophication of Lake Ontario.

e. To measure the extent of *Cladophora* growth and factors which influence the morphology of this area. Emphasis will be directed toward the formulation of means through which the problems caused by this plant can be reduced.

This report details the plans and accomplishments by the staff of the Great Lakes Laboratory (GLL) on the above project during the period from 1 April 1972 through 31 May 1973. The majority of the GLL's efforts in 1972-73 were concerned with the collection of biological and chemical samples as well as making physical measurements in the study zone. The latter consisted of an area eight (8) kilometers wide (as measured from the shore into the lake) and extending in length from the Welland Canal through Rochester. Forty-five (45) nearshore stations were established. These were situated one-half (1/2), four (4) and eight (8) kilometers from shore along lines ten (10) kilometers apart (Figures 1 and 2). In addition twenty-four (24) and twelve (12) stations were located in the mouths and plumes of the Niagara and Genesee Rivers, respectively (Figure 3). The number and location of each of the stations is shown in Table 1. Collection sites for *Cladophora* were established at five (5) locations along lines extending into the lake and perpendicular to the shore. The location of the intersection of these lines and the shore is given in Table 2. Sampling of the attached alga was conducted along the line in water depths of 1, 2, 3, 4, 5 and 6 meters.

Between 1 April 1972 and 31 March 1973 a total of thirteen (13) nearshore, nine (9) Genesee River mouth, seven (7) Niagara River mouth and six (6) *Cladophora* sampling runs were conducted. The dates of the above are shown in Table 3.

Sediment samples were collected on 5 cruises between 18 April 1972 and 25 April 1973 at the nearshore stations. Five (5) sediment samplings each also were completed on the Genesee River and Niagara River mouth stations between 30 May 1972 and 16 May 1973, and 29 May 1972 and 22 May 1973, respectively. These sediment samples were analyzed for sediment chemistry and benthos. Table 4 shows the specific dates of sampling.

It should be noted that a total of eleven (11) nearshore, twelve (12) river mouth and five (5) *Cladophora* sampling runs had been planned for 1972. However, due to a combination of problems including delayed funding of the project, inclement weather and minor mechanical difficulties with the major research vessel, the sampling program had to be reduced. All sampling runs were completed with the exception of the 11-14 December collection that had to be curtailed after ten (10) stations due to severe icing and wave conditions. The primary reason for the extension of the data acquisition phase of the IFYGL project into 1973 was the unreasonably high rain and streamflow during Hurricane Agnes in the spring of 1972.

Since the overall project consisted of biological, chemical and physical components, each of the latter will be discussed separately.

While the Great Lakes Laboratory of the State University College (SUC) at Buffalo conducted the most intensive surveys during IFYGL of the Welland to Rochester nearshore zone, other agencies - including the Canada Centre for Inland Waters (CCIW) - had sampling sites within this region. Their results and conclusions will be published in other reports.

SECTION II

CONCLUSIONS

Through this study, sufficient biological, chemical and physical data were gathered to establish an ecological baseline for the nearshore region of Lake Ontario from the Welland Canal through Rochester, New York. This information, which is available through EPA's STORET files, could be of value to those conducting future assessments of the impact of pollution abatement efforts that affect these waters as well as those concerned with the siting of beaches, power plants, water treatment facilities and other shoreline projects.

The chemical and biological conditions found during the study generally indicated dimictic oligotrophic to mesotrophic conditions. Based on the small quantity of historical limnological information, the area has shown the effects of cultural eutrophication, particularly at the mouths of the Niagara and Genesee Rivers. Water quality generally improved with increasing distance from shore. Abrupt changes in chemical conditions and phytoplankton vs. distance from the shore were particularly apparent when the thermal bar was present. This impact on phytoplankton is discussed in a later section of these conclusions.

While vertical temperature stratifications took place during the limnological summer, chemical conditions above and below the thermocline were not appreciably different.

The major source of nutrients to the study area was the Niagara River, particularly on the nearshore area during the limnological spring. The impact of the Genesee was restricted primarily to the limnological spring. The area of influence of the Genesee was the eastern region of the study area.

Phytoplankton biomass concentrations generally were lower in the spring near the Niagara River mouth than in the other sections of the study area. This may have been due to higher turbidity. However, in the summer and fall the algal levels in the Niagara River mouth exceeded those in the Genesee River mouth. Throughout the year, diatoms were more common in the Niagara region while flagellates generally were more abundant in the Genesee area.

Phytoplankton biomass showed two peaks, one in May, the other in August-September, leveling off in November and December to lower levels. During the spring thermal bar conditions in 1972, there was a distict gradient from high biomass at one-half (1/2) kilometer to lower biomass at eight (8) kilometers. In November and December, the conditions were reversed with higher biomass at the eight (8) kilometer collection sites. During observed maximum phytoplankton biomass concentration in August-September, there was a higher biomass at four (4) kilometers than either one-half

(1/2) or eight (8) kilometer stations.

East-to-west differences within the study area seemed to be influenced by the Niagara River and the relatively shallow Rochester embayment. During May 1972, the most pronounced effect of the Niagara River was observed. There was minimal biomass in the plume area, while in other areas of comparable depth and distance from shore, the phytoplankton biomass were high.

Species composition during the sampling period was similar among the one-half (1/2), four (4), and eight (8) kilometer stations. The only differences were in the total quantity. Diatoms were dominant in April and the fall, diatoms and Pyrrhophyta in May, Cryptophyta at other sampling times, except in August-September when the Pyrrhophyta and Chlorophyta were most abundant. Blue-greens (Cyanophyta) were never a significant part of the biomass.

Although diatoms were of minor importance from July to November at one (1) and five (5) meters below the surface, these phytoplankton were found in high concentrations (>60% of the total) offshore (four (4) and eight (8) kilometer stations) at depths of twenty (20) to fifty (50) meters in July and thirty-five (35) and fifty (50) meters in August as well as 40% at eight (8) kilometers at fifty (50) meters in August-September. They generally increased at all levels from October to December.

The most ubiquitous genera throughout the field year were *Rhodomonas*, *Cryptomonas*, and *Asterionella*. No record of *Peridinium aciculiferum* (Lemmerman) Lindem previous to this study was found in the literature, although *Peridinium* sp. had been reported. *P. aciculiferum* was most abundant in the spring of 1972, reaching average concentrations of 27% of the total biomass in May.

The flora observed was typical of a mesotrophic body of water, especially for the Spring of 1972 when *Melosira binderana*, (*Stephanodiscus binderanus*), a eutrophic-indicating species was present in large numbers shoreward of the thermal bar. The thermal bar appeared to have a considerable impact on the phytoplankton concentration shoreward of the bar. Whether this was due to nutrients and/or temperature was difficult to confirm, but recent reports in the literature and the presence of *M. binderana* indicates that holding nutrients close to the shore is the more likely cause.

With respect to zooplankton in the nearshore area, copepod nauplii were the most abundant identified group, followed by bosminids with mucro and immature cyclopoids. The other common groups in decreasing order of abundance were *Daphnia retrocurva*, *Ceriodaphnia lacustris*, *Cyclops bicuspidatus thomasi*, *Tropocyclops prasinus mexicanus*; immature calanoid copepodids and *Eubosmina* *coregoni.* With the exception of *E. coregoni*, these taxa peaked in September and October. The common cladocerans exhibited their typical pattern of winter and spring abundance followed by very high maxima in late summer and early fall, especially closest to shore.

The seasonal distributions of total zooplankton were similar at the four (4) and the eight (8) kilometer stations with the former sustaining somewhat higher concentrations than the latter. Zooplankton seasonal distribution at the eight (8) kilometer stations was bimodal with peaks in June and October; total zooplankton abundance at the four (4) kilometer stations also reached a zenith during those periods and exhibited an additional pulse in early September after which the decline was small. The density of total zooplankton at the one-half (1/2) kilometer stations was about the same as for the four (4) kilometer stations through June, but then increased markedly to a single extremely high maximum lasting through September. By December (at the six stations sampled) the zooplankton were still more abundant than they had been in the spring, probably because the copepods had not yet reached their low winter levels.

With respect to the seasonal distributions of cladocerans, cyclopoid copepodids, calanoid copepodids, and copepod nauplii expressed as percentages of total zooplankton at one-half (1/2), four (4) and eight (8) kilometers from shore, calanoid copepodids constituted an insignificant part of the total zooplankton. However, they were relatively somewhat more abundant in spring and fall. As expected, cladocerans comprised a small percentage of all zooplankton in spring and late fall at all stations and dominated the assemblage from mid-summer through early fall at the one-half (1/2) kilometer stations. They were relatively less important at the four (4) and eight (8) kilometer stations. Cyclopoid copepodids increased moderately in relative abundance with increasing distance from shore. They accounted for a lesser portion of the total zooplankton from mid-July through late September than during the rest of the year. Copepod nauplii represented about the same percentage composition (40%) at four (4) and eight (8) kilometers from shore, and a smaller fraction (25%) at one-half (1/2) kilometer from shore. They exhibited similar patterns of relative abundance from April through mid-July at all three sampling distances from shore. From late July through November, nauplii comprised a large proportion of total zooplankton at four (4) and eight (8) kilometers from shore than at one-half (1/2) kilometer, yet even at one-half (1/2) kilometer, nauplii accounted for at least 20% of the total zooplankton. In December, nauplii were relatively least important at the eight (8) kilometer stations, but they still constituted one-quarter (1/4) of all zooplankton there, indicating that copepod reproduction was still continuing quite late in the fall in the whole study area. These data demonstrate that copepod nauplii are almost certainly more abundant than these values indicate, because even the fine 64 µ mesh net used in this study does not retain all nauplii.

In the river mouth areas, the common zooplankters were nauplii, immature cyclopoid and calanoid copepodids, bosmia with mucro, *Cyclops bicuspidatus thomasi*, *Eubsomina coregoni*, *Ceriodaphnia lacustris*, *Daphnia retrocurva* (G.R. only), *D. galeata mendotae* (N.R. only), *Tropocyclops prasinus mexicanus* (G.R. only), *Diaptomus oregonensis* (N.R. only). At the Genesee River, the common zooplankters were most abundant in late August or November; at the Niagara River mouth, copepods were most numerous in the spring, and cladocerans in August and December. There were more zooplankton at the Genesee River mouth in Spring 1973 than Spring 1972 and at the Niagara River mouth in the Spring 1972 than Spring 1973. When compared to its nearest nearshore station in Lake Ontario, the Genesee River mouth supported less zooplankton and the Niagara River mouth supported more.

Several species of harpacticoid copepods were encountered in the river mouth regions that had not been reported previously for Lake Ontario. These included *Bryocamptus zschokkei*, *Epactophanes richardi*, *Nitocra hibernica* and *N. spinepes*. From the nearshore, new species included *Alona* sp., *Camptocerus rectirostris*, *Eurycerus lamellatus* and five (5) species of harpacticoid copepods (*Bryocamptus niralis*, *Canthocamptus robertcokeri*, *C. staphylinoides*, *Mesochra alaskana* and *Monaria cristata*).

Concerning benthos, in the nearshore zone the physical nature of the bottom sediments as well as depth appeared to be a more important factor in determing the distribution than did chemical factors. For example, *Pontoporeia affinis* was sixteen (16) times more abundant at the eight (8) kilometer stations than at the four (4) kilometer collection sites. Sphaeriidae also were more common in the shallower waters.

Higher percentages of tubificid worms and other pollution-tolerant forms were found in the regions influenced by the Niagara and Genesee Rivers. This indicated that these tributaries may be sources of organics that contaminated the bottom sediments.

Cladophora growth in the study region also appeared to be more dependent upon the nature of the substrate than on chemical factor or light. Where rocky outcroppings occurred, *Cladophora* growth was abundant. The observed biomass peaks in July and October coincided with the growth patterns for this attached plant that have been observed in other Great Lakes.

With respect to the relative concentration of nutrients in the nearshore sediment, lower quantities of phosphorus and nitrogen correlated directly with the percentage of sand in the bottom materials. There also appeared to be relationships between some chemical forms of the nutrients and the deposition pattern of the plankton. The highest total phosphorus (P_T) values were observed in the early spring. Following a slight decline that occurred until turnover, the P_T of the sediment remained fairly constant through the late fall-early winter. However, the total water soluble phosphorus (P_{TWS}) declined from late June through mid-September, indicating that these nutrients were chemically or biochemically regenerated and/or transferred in those regions covered by hypolimnetic waters. It is believed that biological activity, desorption from Fe complexes and water movements may be major factors accounting for these observed changes. This regenerated phosphorus may have been an important source of this nutrient for plankton. The settling of planktonic and sestonic material in the late fall and early winter was thought to be an important factor in the P_{TWS} increase during that period.

Both P_T and P_{TWS} phosphorus as well as nitrate nitrogen at the Genesee River mouth exhibited no statistical change with time or distance from shore. Concentrations of the nutrient in the Genesee area were the highest within the study area and believed to be correlated to the clay and silt content of the bottom material.

Sediment nitrate nitrogen in the nearshore zone decreased markedly during spring and fall turnover while increasing during stratification. Highest nitrate concentrations were observed in the early spring following winter stagnation. A possible positive correlation between changes in the sediment nitrate levels and deposition of plankton was noted.

Ammonia nitrogen remained fairly constant in the nearshore area except for a decline between late May and early June which may have been due to turnover. The highest observed ammonia concentrations were noted during the late summer and early fall at the mouth of the Genesee River.

Higher concentrations of organic and total nitrogen were recorded at the eight (8) kilometer than at the four (4) kilometer stations. The quantities of these chemicals were lowest following spring turnover and highest in the early spring. This was similar to the pattern for nitrates.

Carbonate and organic carbon concentrations (CC and OC, respectively) were observed to be generally higher at the four (4) and eight (8) kilometer rather than the one-half (1/2) kilometer collection sites. This was attributed to higher clay content at the off-shore sites. Maximum and minimum CC concentrations were noted in the early spring and fall, respectively. The OC was highest in the early fall and lowest during the early spring of 1972. However, during 1973, high OC values were recorded in the spring at the eight (8) kilometer stations. Organic carbon content appears to correlate with the deposition and resuspension of planktonic material. The variations in the carbonate carbon may have more a direct function of pH and temperature. The pH decreases and temperature increases; carbonate, which in Lake

Ontario is primarily in the form of calcite, increases in solubility.

High organic carbon content was found in the sediment at selected stations in the Niagara River plume as well as at the mouth of the Genesee River. The sediment entering the lake from the latter tributary had a lower CC content than was noted in the nearshore stations.

Sedimented heavy metals were impacted by both the Genesee and Niagara Rivers. Generally, sedimented metals were highest in the areas immediately east of the plume of the Niagara River and in the Rochester Embayment, regardless of the sampling dates. The only statistically significant variation in sedimented metals content was an increasing concentration with distance from shore. This areal distribution pattern correlated with the increasing clay content, distance from shore, and water column depth.

The sediment in the area of the Niagara River had a high percent dry weight as well as a high fixed and low volatile solid percentage. These characteristics were attributed to the large amounts of sand in this material. In contrast, the material from the nearshore and Genesee River region generally had a low percent dry weight and higher volatile solids content. The greater sorptive capacity of the silty-clay in these regions was believed to be a major factor for that observation.

With respect to nutrients in the water, total phosphorus (P_T) remained relatively homogenous throughout the water column during the unithermal period. The P_T concentration in the hypolimnion was higher than the values from the epilimnion. The former correlated with a decrease in P_{TWS} of the sediment, indicating that the increase in the hypolimnion may have been due to a regeneration of phosphorus from the sediment.

Dissolved phosphorus (P_D) also was highest during turnover and lowest during periods of stratification.

Ortho phosphorus (P_O), which was found in concentrations lower than those previously reported for Lake Ontario, is believed to be in equilibrium with the other forms of phosphorus.

The water from the Genesee plume had the highest P_T content, particularly during the early spring. This was attributed to the large percentage of land in the Genesee River Basin that is used for agricultural activities. The ratio of algal to total phosphorus concentrations between the Genesee, nearshore and Niagara areas, indicated that the high concentration of the phosphorus from the Genesee did not immediately stimulate algal growth. This was believed due to the fact that most of the phosphorus in the spring run-off was associated with particulate material which also increased the turbidity to a degree that light became a limiting factor.

Nitrate nitrogen decreased as stratification increased. Ammonia, in contrast, increased during this same period.

In the nearshore region, nitrate and dissolved silica concentrations were higher in the bottom than in the surface waters, while ammonia values showed no pattern of variation with depth. However, at the mouth of the Genesee, there was a decrease in ammonia from the surface to the bottom. Nitrate levels in both the Niagara and Genesee River collections were higher at the surface or mid-depth regions than at the bottom.

Dissolved silica concentrations at the mouths of the Niagara and Genesee were higher during the summer than in the spring.

Both dissolved silica and nitrate nitrogen increase in concentration with distance from shore. Silica also was higher in the western end of the study area than in the eastern area. This may have accounted in part for the higher populations of diatoms in the western sector of the study area.

Water quality indicators calcium, magnesium, potassium and sodium ions were relatively constant over the entire study period and showed no statistically significant spatial or temporal variations.

Iron, cadmium, copper, lead, nickel, manganese and zinc concentrations were a function of inputs from the Niagara and Genesee Rivers, particularly of the former. Generally, higher concentrations were found in the vicinity of the Niagara River mouth. Except for higher nearshore manganese concentrations, no other spatial or temporal variations were found to be statistically significant.

Both halogens, chloride and fluoride as well as sulfate and organic carbon concentrations were highest in the areas near the river mouths, especially the Niagara. This suggested a definite impact from the allochthonous water sources flowing into Lake Ontario. The only statistically significant areal distribution for any of these four constituents was a decrease in fluoride concentration with distance from shore. Some evidence also exists for the possible regeneration of sulfates from the sediment, since hypolimnic or bottom water concentrations during stratified periods were consistently higher than the values obtained in surface and mid-depth samples. Total organic carbon content, as a factor of the higher biomass and chlorophyll were higher inshore of the thermal bar. The lack of data generated by the Rochester Field Office and the large degree of variability on the results retrievable from STORET are believed to be the primary reasons for the lack of correlations among these four water quality parameters.

As anticipated, there were positive correlations between chlorophyll-a (chl-a) and phytoplankton biomass. For example, during stratification, the chl-a was higher in the epilimnion than in the hypolimnion. The highest observed chl-a values were noted at the mouth of the Genesee during late June and August 1972. Significantly greater chl-a quantities were observed in the early spring in the shoreward region of the thermal bar.

SECTION III
METHODS AND MATERIALS

PHYSICAL

Temperature

Thermal measurements were gathered by means of a Hydroproducts thermister and probe.

Temperature profiles at the one-half kilometer (1/2 km) and river mouth stations during each cruise were taken at the surface(s), one-half (1/2) and each meter to the bottom. At the four (4) and eight (8) kilometer nearshore stations readings were recorded at the surface(s), one-half (1/2), one (1), two (2), five (5) and fifteen (15) meters as well as at successive ten meter (10 m) intervals to the bottom.

Dissolved Oxygen

The oxygen content of water samples from a meter below the surface (S-1), mid-depth (M) and a meter above the bottom (B+1) was determined using the Azide modification of the Winkler Dissolved Oxygen Method (APHA 1971).

Dissolved oxygen profiles using a Model 715 Beckman Oxygen Monitor probe were taken at the same depths as the temperature readings during the initial four nearshore cruises in 1972. However, the procedure was discontinued in favor of the more reproducible wet-chemical procedure. When the Beckman Oxygen Monitor was employed, its accuracy was checked against the Winkler Method for determining dissolved oxygen that was noted above.

Light

Two Model 268WA310 Kahl Scientific Submarine Photometers were employed to measure light intensity. Light measurements were taken at the same depths as the temperature readings. However, the malfunction and subsequent delay in the repair of the photometers resulted in the absence of light values from the Genesee River mouth stations during June through August 1972.

Light values were collected on the sunward side of the sampling vessels to avoid shaddowing. Two sets of readings - one made as the photocell was lowered and the second as it was raised - were taken at each station.

BIOLOGICAL

Phytoplankton

Phytoplankton water samples were collected from the R/V C. A. Dambach for the 45 lake stations and from a 16' Boston Whaler or the Dambach for the 36 river mouth stations in 1972 and 1973. The dates of collections are listed in Table 3. In 1972 phytoplankton was collected on all the Lake Cruises except Cruise III (June). During Lake Cruise X, plankton could only be gathered at 10 stations due to the weather in December.

Samples were collected by means of 4.1 liter PVC Van Dorn Bottles at depths of 1, 5, 20, 35 and 50 meters (depth permitting) in the lake and 1, 5, 10, 15, 20 and 25 meters at the river mouths. One liter was transferred to glass bottles and preserved with Lugol's iodine (1:100) (Vollenweider 1969) for later analysis.

The basic procedure used for phytoplankton analysis was that of Utermöhl (1958) as amplified by Lund et al. (1958), Munawar (1972) and Lorefice (1974) using the inverted microscope. In most cases a 50 ml subsample was sedimented in special chambers (WILD) for at least 24 hours before enumeration.

The enumeration was accomplished using a Wild M-40 inverted microscope with phase objectives. Each chamber was analyzed by counting the cells in one or two transects across the chamber. There were 40 fields in each transect. In most cases the 20x objective was used, resulting in a magnification of 300x in combination with the eyepieces. This was sufficient for identification of most species.

Due to the large number of samples and the amount of time required to count them, it was determined, after the first two lake cruises had been analyzed, to restrict the stations to 7 of the 15 transects or 21 stations. These transects were representative of what was occuring in the nearshore zone. Of these 7 transects, 4 were selected (12 stations) for analysis of all samples to the depth of 50 m. In the other transects only 1 and 5 meter samples were examined. The stations selected for vertical profiles were: 201, 202, 203, 222, 223, 224, 231, 232, 233, 243, 244, 245. Samples for the Genesee and Niagara River mouths were also selected in the same manner as the lake samples. These stations are listed on page 67.

Taxonomic identification was accomplished by reference to numerous keys and monographs and by consultation with Dr. M. Munawar at CCIW. The major references used were:

Huber Pestalozzi (1938-1962)
Patrick and Reimer (1966)

Prescott (1962)
Taft and Taft (1971)
Tiffany and Britton (1952)
Weber (1971)

The phyla suggested by Prescott (1962) was followed for the most part.

It appears necessary to explain the taxonomy used to identify some of the species, especially the difference between *Melosira binderana**Kutz. and *Stephanodiscus tenuis* Hust. In our observations we found it possible to distinguish between *M. binderana* and *S. tenuis* by shape and size of cells. The cells of *M. binderana* had a mean length of 168 µ and a mean diameter of 10.5 µ, whereas *S. tenuis* had a mean length of 10.5 µ and a mean diameter of 16.0 µ. *M. binderana* was found almost exclusively as a filament whereas *S. tenuis* as individuals or groups of 2 or 3 cells. In our collections there was enough difference in the diameters and physical appearance of cells for us to confidently distinguish between the two taxa.

Biomass

In the initial analysis, data were recorded in cells/ml. However, it was felt that some other form of biomass presentation could better reflect the phytoplankton population. With the microscopic technique only cell numbers and cell volume could be determined directly. Cell numbers were converted to cell volume by simulating the algae to geometrical shapes like a sphere, cylinder, cone, etc. using length and width of organisms. A minimum of 50 individuals were measured for the ten most dominant species. Each cruise was considered separate and the mean of all the cells measured from 5-10 samples for that cruise was used in the calculations for that cruise only. See Table 8 for the $\bar{x}$ volumes of major species for 1972-1973. The cell volume was then converted to mg/m^3 assuming that the specific gravity of algae was unity. Therefore all data presented in this report is in mg/m^3.

Our use of the convention mg/m^3, based on volume of individual cells, was arrived at after careful consideration of the literature. Since the most recent lakewide work on Lake Ontario was expressed as volume measurements (Munawar and Nauwerck 1971), the close proximity of that senior author to this lab and a need for standardization of methods in the phytoplankton area, the methods presented here were adopted.

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* Round (1972) transferred this species to *Stephanodiscus binderanus* (Kütz) Krieger.

It was also realized that presentation of data using volumes (μ^3) or weight (mg) was not free of its errors due to differences between cell volume and plasma volume. However, these differences appeared less than the differences found in presenting data in cell numbers. It is important to note that all the following biomass data is also available as cells/ml.

Zooplankton

At each station a single vertical haul was taken from just off bottom to the surface with a 1/2 meter #25 plankton net (mesh aperature 64 μ). Samples were preserved with 10% buffered formalin and 5% glycerin.

A minimum of 200 animals, excluding nauplii, were counted from each sample as per Patalas (1969) and Watson and Carpenter (1974). In addition, nauplii were also enumerated. All cladocerans were identified to species with the exception of bosminids with mucro which were saved for species identification at a later date. Despite the work of Deevey and Deevey (1971), the taxonomy of bosminids with mucro remains uncertain. Wilson (Personal Communication) has stated that there do not appear to be more than two major bosminid species in the offshore waters of Lake Ontario, but that there is probably a larger number of species inshore. Nonetheless, perhaps a majority of the bosminids with mucro were *Bosmina longirostris*. The nauplii of all copepods were counted jointly as one identification group. Calanoid copepodids from the Lake Ontario samples were identified to species, stage and sex (where differentiated) using the method of Czaika and Robertson (1968), but for the purpose of this report only the species of adults are reported with all immature calanoid copepodids lumped as one identification group. In order to draw statistically accurate conclusions about the seasonal distributions of the various calanoid life history stages, more animals should be identified than occurred in the aliquots used in this study. Immature cyclopoid copepodids from the Lake Ontario samples were split into two groups, those with 2 or 3 pairs of swimming legs (CI and CII) and those with 4 big pairs of swimming legs (visible under the dissecting scope) (CIII, CIV, CV). Copepodids from the river mouth samples were divided into two groups, immatures and adults, with only the adults identified to species. The results are reported as numbers/m^3 to reflect the concentration of animals. However, such an expression is biased against the deeper stations at which most of the zooplankters are absent from a good deal of the water column (Davis 1968; Patalas 1969). The concentration of animals was calculated assuming a sampling efficiency of 100%. However, the actual filtration efficiency of a plankton net is poor (Rawson 1956). Therefore the values reported herein are relative concentrations (Patalas 1969).

Benthos

Three (3) Ponar grabs were taken at each station sampled. On the collections through August 1973, all three were combined then sieved as a unit. After August the three (3) Ponar grabs were sieved individually.

The use of an Ekman Dredge was terminated after the initial cruise due to the fact that collections with this device could be made at less than a third of the sites where Ponar collections could be made.

Samples were sieved on a #30 mesh (0.595 mm openings) sieve. The material that was retained was preserved in glass jars with 10% neutral formalin, 5% glycerin solution. Organisms were separated by major taxa (Oligochaeta, Sphaeriidae, Amphipoda, Isopoda, Chironomidae, etc.) and counted under dissecting microscopes. In those samples where large volumes of organisms were present, samples were split by taking a known percentage of the entire sample after it had been sieved. In all cases samples were made comparable by equating results to number per m^2. Taxonomic identification was accomplished by randomly selecting 100 individuals, where possible, from each major taxa and mounting in various media on microscope slides. Identification to species was then attempted by use of a compound microscope. The following references were the primary sources used to identify the major groups of organisms found:

Oligochaeta - Brinkhurst and Jamieson, 1970; Hiltunen, 1973
Chironomidae - Mason, 1973
Amphipoda and Isopoda - Holsinger, 1972

Cladophora

Cladophora samples were collected by SCUBA divers close to shore at Stations 207, 216, 222, 228 and 237 at depths of 2 to 6 meters. A one square foot hoop was thrown into the various depths of water and all the *Cladophora* contained within three such casts was scraped off the rock and placed in sample jars. Upon receipt of this material in the laboratory, ash-free dry weights were determined as an indication of *Cladophora* biomass.

Data Handling

Due to the unavailability of the proposed "Biofind" systems, the GLL in conjunction with the SUC at Buffalo Academic Computer Center, undertook to develop its own biological data system. A numerical taxonomic system has been established for phytoplankton and zooplankton. At present all the IFYGL phytoplankton data is on cards in the Fortran IV language. An interpretive program has been set up to do all calculations and assemble the data in a more usable form. A zooplankton interpretive program will hopefully be set up in early spring. A benthic macroinvertebrate taxonomic system is presently being established.

CHEMICAL---SEDIMENT

Nutrients

Sediment samples collected with a Ponar Dredge were analyzed for total phosphorus (P_T), dissolved phosphorus or total water soluble phosphorus (P_{TWS}), nitrate (NO_3-N), ammonia (NH_3-N), organic (org-N) and total nitrogen (N_T), organic (OC) and carbonate carbon (CC). Phosphorus analysis was performed on wet sediment according to Wyeth (1973). Nitrogen analyses were performed according to the method presented in the Laboratory Manual of the Cleveland Program Office (FWPCA 1967). OC and CC results were based on dried sediments. A Coleman Carbon-Hydrogen Analyzer was used in these determinations. Total sediment carbon content (TC) was found and after acidificates, the organic carbon (OC) level was determined. Carbonate carbon (CC) was found by difference.

Toxicants

Those elements or compounds considered toxicants for which analyses were made included: metals (iron, magnesium, manganese, copper, chromium, nickel, cadmium, mercury, zinc and lead) and pesticides (lindane, heptachlor, aldrin, heptachlor epoxide, dieldrin, p,p'DDE, o,p'FDE, endrin, o,p'DDF, p,p'FDE, p,p'DDF, chlordane, toxaphene, PCB's).

All metals except mercury were determined on acid-digested sediments. A Varian Model 1200 and/or Jarrell-Ash Atomsorb were used in these determinations. The appropriate analytical wavelengths, flame conditions, and other necessary information was taken from the Methods for Chemical Analysis of Water and Waste (EPA 1971). Mercury content of the sediments was determined by Hatch and Ott (1968) and Bradenberger and Bodes (1967).

All pesticide analyses were conducted by the Lake Ontario Environmental Laboratory (LOTEL) of the State University College at Oswego under the direction of Dr. Richard B. Moore. Immediately upon receipt of sediment samples and after blending, aliquots were placed in plastic vials and mailed to LOTEL. Dr. Moore should be consulted regarding sample preparations and analyses via electron capture gas chromatography.

Quality Indicators

The only indicators of sediment quality used for Lake Ontario muds were based on the results of solids analyses. Percent dry weights, percent fixed weights and percent volatile weights were determined according to Standard Methods for the Examination of Wastes and Wastewater (APHA 1971) where the sediment was considered a sludge sample.

CHEMICAL---WATER

Nutrients

Samples were collected from all stations (lake and river mouth) from 3 depths (surface, mid-depth and bottom) during all cruises. These samples, approximately 2600, were delivered to the Rochester, New York Field Office of the U.S. Environmental Protection Agency. The nutrient analyses scheduled to be performed on each of these samples were NH_3, Kjeldahl-N, NO_2 and NO_2, phosphorus (total, dissolved and ortho), and dissolved silica. The methods of preservation and analyses employed were from the Method for Chemical Analysis of Water and Wastes (EPA 1971).

Toxicants

The above mentioned samples were also to be analyzed by Rochester EPA for toxicants. Toxicants included cadmium, copper, lead, nickel, manganese and zinc. Samples were analyzed for their heavy metals according to the EPA approved methods (EPA 1971).

Quality Indicators

Other analyses to be performed by the Rochester Field Office on water samples collected by the GLL included total organic carbon, calcium, magnesium, sodium, potassium, sulphates, fluorides and iron. Water was also filtered on board the Dambach and transported to the Buffalo Labs of the GLL for chlorophyll analysis.

The analyses for quality indicators that were performed by Rochester Field Office were in accordance with the EPA (1971) approved methods.

Chlorophyll analyses were performed according to the method by Parsons and Strickland (1963) and calculated using the SCOR/UNESCO equation:

$$\text{Chl-}\underline{a}\ (\mu g/l) = F\ [11.64\ ({}^{OD}663_{COR}) - 2.16\ ({}^{OD}645_{COR}) + 0.1\ ({}^{OD}630_{COR})]$$

$$\text{Chl-}\underline{b}\ (\mu g/l) = F\ [20.97\ ({}^{OD}645_{COR}) - 3.94\ ({}^{OD}663_{COR}) - 3.66\ ({}^{OD}630_{COR})]$$

$$\text{Chl-}\underline{c}\ (\mu g/l) = F\ [54.22\ ({}^{OD}630_{COR}) - 14.81\ ({}^{OD}645_{COR}) - 5.53\ ({}^{OD}663_{COR})]$$

$$\text{where } F = \frac{\text{vol. (extract) in ml}}{\text{vol. (filtered) in l x path length in cm}}$$

and ${}^{OD}663_{COR}$ = (${}^{OD}663$ - ${}^{OD}750$) before acidification

${}^{OD}645_{COR}$ = (${}^{OD}645$ - ${}^{OD}750$) before acidification

${}^{OD}630_{COR}$ = (${}^{OD}630$ - ${}^{OD}750$) before acidification

For pheophytin-a and corrected chlorophyll-a the following equations were used:

Corrected Chl-a (μg/l) = $F[26.7\ ({}^{OD}663_b - {}^{OD}663_a)$

and Pheo-a (μg/l) - $F\ [26.7\ (1.7\{{}^{OD}663_a\} - {}^{OD}663_b)]$

where ${}^{OD}663_a$ = OD 663 corrected after acidification

and ${}^{OD}663_b$ = OD 663 corrected before acidification

The results of data acquisition for both sediment and water analyses have been submitted to and inputed in the STORET system. GLL's final IFYGL report is based on the data as retrieved from the STORET system. It is estimated that of the 2600 bits of information on water analysis that could have been generated for each parameter, only 10-20% is retrievable via STORET. The results and discussion of the water data, therefore, are based on only a fraction of the samples delivered to Rochester. The quality and quantity of specific data will be mentioned in appropriate sections of this report.

Various schemes of data reduction have been employed to interpret the retrieved data. The STORET retrieval, INVENT, has been used to determine mean, standard deviation and ranges for the various parameters at all stations. Averages have been calculated for the results from the 1/2, 4 and 8 km contour and for various areas in the study region (i.e. near the Niagara River Mouth, etc.). Some transect averages were calculated as well.

The time periods being discussed may vary in different sections of the report, but generally three schemes were applied. The first scheme was to group the data by cruise (Table 3). A second method of data reduction in terms of time was to look at the data grouped by season: Period 1 - 1 April to 1 June 1972 (Spring unithermal); Period 2 - 2 June to 5 October 1972

(Stratified period); Period 3 - 6 October 1972 to 1 June 1973 (Fall-Spring unithermal). If a significant amount of data was available, a third time-data reduction scheme was used where Period 3, from above, was divided in two sections - Fall-Winter 1972 and Spring 1973.

The data was also divided by depth and reinventoried for all parameters at all stations. An average thermocline depth of 20 meters was used to examine results obtained during thermal stratification. Invent retrieval then yielded averages and deviation ranges for results above and below 20 meters for any one of the time periods selected.

Statistical analysis, including chi-squared and analysis of variance also were used where applicable.

The actual time scheme and data reduction used for a particular parameter was covered in each respective portion of this report.

SECTION IV
RESULTS

The results of the chemical and physical measurements made in the field by the staff of the Great Lakes Laboratory as well as the values obtained through the quantitative analyses of sediment were forwarded to EPA's Grosse Ile Laboratory. These data have been entered into STORET, from which they can be retrieved. Since this information is readily available, the authors of this report elected not to include every value generated through this study. However, since a data bank has not been devised to date to handle the IFYGL biological information, the results of the GLL's biological analyses are related in more detail than the chemical or physical data.

PHYSICAL

Temperature

The researchers involved with the IFYGL project were concerned with horizontal as well as vertical chemical stratification in the study area. Of particular interest were thermal bars (Figure 4).

A thermal bar was present during the 18 April through 3 May 1972 period. It extended between Stations 202 (4 km) and 203 (8 km), and also between Stations 204 (1/2 km) and 205 (4 km) to the mouth of the Niagara River. To the east it reappeared to the shoreward side of Station 210 (1/2 km), extended between Stations 213 (1/2 km) and 214 (4 km) and again to the shore south of Station 216 (1/2 km). From the latter it was present between the 1/2 and 4 km stations through 219 (1/2 km) and 220 (4 km). East of the 234 (1/2 km), 235 (4 km) and 236 (8 km) chain it intersected the shore to the south of Station 237 (1/2 km). To the east the thermal bar again was found between the 1/2 and 4 kilometer stations.

On the 10-23 May 1972 cruise the bar had moved lakeward. It was observed between Stations 202 (4 km) and 203 (8 km). However, instead of moving to the shore, it extended to the north of Stations 206 (8 km) and 209 (8 km). To the east it stretched just below the 4 km Stations 211, 214, 217 and 220 from which it was found between the 4 and 8 km stations through 238 and 239. It was north of 8 km Stations 243 and 245.

A vertical profile transect of temperature from 1/2 to 8 km demonstrated the classic thermal bar pattern as presented by Rodgers (1966) showing a barrier of 4°C water from surface to bottom separating the >4°C water from the <4°C water.

During the 1973 collection period the thermal bar was similar in terms of its extent and movement as the 1972 observations. The bar moved offshore at a rate of approximately 1.3 km/week after the initial observation each spring. However, in 1973 the thermal bar formed earlier than in 1972 and moved lakeward at an earlier date.

The Niagara and Genesee Rivers each have a pronounced impact on the formation of the bar, During April each year colder waters from the Niagara inhibited the establishment of the bar at the river mouth and for approximately six kilometers (6 km) to the east. During 1973 there was evidence of a thermal bar to the west of the Niagara River. On the other hand, the Genesee River mouth and Rochester Embayment contained water in April that was greater than 4°C, which was warmer than the Niagara. As a consequence the thermal bar moved much further from shore than was noted at the collection sites to the west.

Between the end of April and mid-May a thermal bar did form in the vicinity of the Niagara River. By this period the bar extended beyond the Great Lakes Lab's most lakeward station in the Rochester Embayment.

To the west of Stations 213, 214 and 215, the uniformity of the thermal bar for April 1973 resembled the shoreline configuration until its extension lakeward in the Rochester Embayment. To the west the colder waters of the Niagara had a pronounced effect of depressing the thermal bar shoreward. By May 1973 the uniformity of the thermal bar extended east and west on the lakeward and shoreward side of the 8 km stations. In comparison, the 1972 thermal bar showed less uniformity. The shoreward depression of the thermal bar east of the Niagara was observed into May. There the shoreward depression was from the lakeward side since the waters at the Niagara River mouth were greater than 4°C.

As was noted earlier, there was no thermal bar observed to the west of the Niagara during April 1973 in contrast to the noting of a thermal var in this location in April 1972. Yet by May 1973, a thermal bar did form and extended further lakeward than the May 1972 thermal bar. Possible variation in circulation between 1972 and 1973 in this vicinity could account for this observation.

With respect to vertical temperature stratification, isothermal conditions were observed on the 18 April through 3 May and 10 through 23 May 1972 cruises. During the 19-28 June cruise, a thermocline was present between 5 and 10 meters at most stations. The stratification was found between 15 and 20 meters on both Cruise IV (12-21 July) and V (25 July - 2 August).

At the end of July and beginning of August 1972, the peak temperatures and greatest ranges in vertical thermal stratification were noted (Cruises IV and V). Between mid-September and October there was a decrease in temperature (~4°C) in the surface waters, lowering of the thermocline, and elevated temperatures below the thermocline (~4°C). On the 5-13 September cruise the thermocline was observed between twenty (20) and twenty-five (25) meters at the 4 km and 8 km stations. However. the thermocline had risen to 15 meters at the 4 and 8 km stations on Cruise VII (21 September - 4 October). On Cruise VIII the thermocline had sunk below 45 meters. The last stratification was noted at Station 220 on 30 October. On Cruise IX (6-22 November) and X (11-14 December) the water was isothermal with slightly warmer conditions found at the 4 and 8 km stations.

An examination of the vertical temperatures observed at Station 232 illustrated the changes noted during the field phase of the study (Table 5).

Thermal conditions for offshore waters for April 1973 tended to be warmer than those noted in April 1972. During May 1973 the temperatures were equal to or slightly warmer than in 1972. The greatest temperature ranges (surface to bottom) for April and May 1973 were observed west of Stations 222-224 transect. In 1972, the eastern portion exhibited the greatest range.

In late May 1972 to June, waters for the Niagara River were higher in temperature (4 to 6°C) than the offshore waters (Figure 2). The offshore waters (upper 1/2 meter had values within 2°C of the river mouth and surrounding stations (382, 383 and 386). During this time the Niagara River mouth was isothermal, whereas the Genesee River mouth had the largest observed variance in terms of vertical temperature profile. These differences may have been due to the slower flow of the Genesee as compared to the Niagara. Temperatures of the Genesee generally were 5 to 8°C warmer than the Niagara.

An examination of the vertical temperatures observed at Station 232 illustrates the changes noted during the field phase of the study.

By mid-June the waters at the Niagara River mouth increased in temperature by as much as 9°C, and exhibited few differences in vertical temperatures. The Genesee had a smaller increase, 1-2°C, over the same period. While the temperatures were similar to the values of the Niagara, vertical stratification was noted in the Genesee River mouth. Surface values in the Genesee River mouth were similar to offshore surface readings, but colder waters still prevail below approximately 5 meters.

From the end of July to the beginning of August, Niagara River mouth temperatures tended to be slightly higher (1-2°C) as compared to the offshore stations. The Niagara had little vertical differences (less than 1°C average from surface to bottom). The Genesee had a 2 to 6° difference from surface to bottom by mid-August. However, this decreased to only 1 to 2°C from surface to bottom by the end of August.

In mid-November isothermal conditions existed for the offshore as well as the river mouth stations. For example, the Genesee stations showed 1/2°C variation from surface to bottom. Offshore temperatures were slightly higher than the river mouth by approximately 1°C.

In mid-May 1973 the Genesee had approximately a 2°C temperature variation from the river mouth to the offshore stations. The river mouth stations were higher in temperature. Due to a lack of data, no comparisons between the springs of 1972 and 1973 can be made for the Genesee River mouth.

Most of the Genesee River mouth stations were consistently within the plume of the river. However, Stations 356, 357, 361 and 362, which were farthest from the river mouth were more representative of the nearshore stations. Stratification was greater at these sites, perhaps due to the slow discharge of the Genesee. The Niagara offshore stations tend to differ in value much more than those near the Genesee. Temperatures of these Niagara River mouth sites showed little resemblance to adjacent nearshore stations. Due to its large discharge, extensive mixing and variable nearshore currents, the Niagara River plume was characterized by little stratification and greater variability.

Dissolved Oxygen

No significant differences were observed between the dissolved oxygen profiles among the 1/2, 4 and 8 km stations on any single cruise. As in the case of the temperature data, the general trends with respect to changes in dissolved oxygen content of the nearshore waters could be ascertained through the examination of the changes noted at a single station over the course of the field phase. This is shown in Table 6.

Oxygen values ranged from approximately 75 to 150 percent saturation. Saturations below 100% were measured below the thermocline in the majority of cases. In contrast, the epilimnetic waters observed were at or above saturation.

General seasonal trends observed for the nearshore stations were as follows. From mid-April to beginning of May, the lowest values observed were west of the Niagara (~97% saturation). In mid-May most stations exhibited 100% saturation plus. From mid-May to the end of June and beginning of thermal stratification, the waters at or below 20 meters in the Rochester Embayment showed the lowest oxygen saturations (less than 90%).

During Cruise IV in mid-July, the western nearshore stations had the lowest values but each was above saturation. By the end of July and beginning of August there were little differences in oxygen levels between stations. In the first half of September, stations west of the Niagara had the lowest values. The oxygen values at depths of 50 meters or more were quite similar from station to station. By the end of September and beginning of October, the oxygen values at the eastern stations had decreased to the levels noted at the western sampling sites. Below the thermocline, saturation levels between 70 and 95 percent were measured. From the middle of October to the beginning of November, all stations had 90 to 95 percent saturation on both horizontal and vertical planes. This condition was indicative of turnover. For December, data for the western stations continued to be similar as the previous two cruises.

In April 1973, 90 to 100% saturation levels were observed at all stations. At the two offshore transects east of the Niagara and the Genesee River mouths, saturations in the 80% range were noted. By the end of April to mid-May, the saturation values had increased to above 90%. During Cruise XIII at the end of May, a consistent increase in oxygen saturation to or near 100% was noted.

The lowest oxygen saturations were observed during Cruises VI, VII and VIII from the beginning of September to the end of October. During stratification, there generally was at least a 10% saturation difference above and below the thermocline.

During Cruise I and II in 1972, oxygen percent saturations inside the thermal bar, shoreward, were higher than the lakeward side. These values ranged from a 10% to 25% saturation difference. This can be seen in Table 6 for Stations 231 vs. 232, 233 for Cruise I, and Station 231, 232 vs. 233 for Cruise II where the thermal bar intersected the transects. In 1973 for Cruises XI and XII, the same condition was observed except that the saturation values varied by only 4 to 6%. In general, all stations reported a greater oxygen saturation inside the thermal bar. At Station 243, just east of the Genesee River, the opposite was noted (87% saturation). Dissolved oxygen levels of 95% were noted at Stations 244 and 245 which lie outside the thermal bar during Cruise XI for April 1973.

In general, for June and the end of August 1972 as well as mid-May 1973, the Niagara and Genesee River mouth oxygen saturation values were very nearly equal. The highest values observed were during the beginning of June after which levels declined in mid-June and generally leveled off through the beginning of December.

The oxygen values measured at the river mouth stations for both the Genesee and Niagara Rivers were similar to those at nearshore stations for the end of August, mid-December (for the Niagara) and mid-May (for the Niagara). Mid-June data indicated a slightly higher oxygen saturation at the nearshore stations. Waters at or near the bottom were at the same saturation values as the river mouth values even though the bottom water temperatures were 5°C colder.

Light

For the 8 km stations at 1/2 meter below the surface, the light levels were at least 60% of incident surface illumination during all the cruises. At the first meter, transmission decreased to approximately 60%. By 2 meters the percentage dropped to between 20 and 60%. Most of the higher readings were noted at the stations to the east of the Niagara. The values recorded at the nearshore stations in the vicinity of the Genesee River were among the lowest observed. At 5 meters values were 40% or less at most stations. By 15 meters there was less than 20% transmission at most collection sites. The compensation point of 1% and less for the transmission of light was recorded at 25 meters, with the exception of June to the end of September 1972 and the Spring of 1973 for the transects near the Niagara and Genesee Rivers. The compensation point at these stations was at approximately 15 meters. This was the only seasonal change noted.

At the 4 km stations, 60% transmission of incident surface illumination was noted in the first 1/2 meter with the highest values (80-100%) at Stations 220, 223, 226, midway between the Niagara and the Genesee. The same trend occurred at 1 meter depths with the values predominantly between 60 to 80%. At 2 meters, the range was largely 20 to 40% transmission. By 5 meters the values were less than 20%. Values at 1% and less remained consistently at 15 meters with few exceptions in the central offshore stations.

The light measurements at 1/2 km stations at 1/2 meter had ranges that varied from 60 to 100% of incident surface illumination. The values recorded below the surface at the stations east of the Genesee were 20% lower on the average. The 1 meter readings ranged from 40 to 80%. The two meter values averaged 20% lower. One percent and less light transmission was noted at 5 meters for Stations 201, 204, 207, 231 and 240, and also at 2 meters at the collection sites east of the Genesee.

Due to fluctuation of offshore circulation patterns, the greatest influence of the Niagara was exerted on the adjacent west 1/2 km and 4 km stations and on the adjacent east 8 km station. The diffuse flow pattern of the Genesee discharge had an equivalent effect on both adjacent transects with a slightly stronger influence on Stations 243 (east 1/2 km stations) and 241 (west 4 km stations).

Due to lack of a systematized and coordinated collection of turbidity data, it is not statistically valid to contrast turbidity results obtained from the river mouth collection sites with the values obtained from the nearshore sampling stations. The river mouth stations did exhibit greater turbidity than the nearshore stations. This was especially true for the Genesee River mouth stations. The Niagara collection sites had the greatest clarity during the Spring of 1972. The greatest turbidity was observed in December of 1972.

The impact of Tropical Storm Agnes on light transmission was short-lived and restricted primarily to the mouths of the Genesee and Niagara Rivers. The impact on the Genesee River mouth area was pronounced in terms of decreasing light measurements for a longer period of time than was the influence on the Niagara River mouth. While smaller tributaries that discharged into the Welland Canal to Rochester nearshore area undoubtedly were influenced to some extent by Tropical Storm Agnes, no physical evidence of changes due to this weather event was observed. (Similarly, no biological or chemical alterations in the study area beyond the Niagara and Genesee River mouths as a consequence of Agnes were noted during the study by the Great Lakes Laboratory.)

No other noteworthy weather event that was believed to have a direct influence on the study area occurred during the field phase of the GLL's 1972-73 IFYGL project.

The impact of the higher than average water levels of Lake Ontario which were present during 1972 and 1973 could not be assessed.

BIOLOGICAL

Phytoplankton Biomass-Distribution

The April and May cruises (I and II) 1972 showed definite zonal relationships of biomass among the 1/2, 4 and 8 km stations (Figure 5). From these data a number of biomass isopleths parallel to the shore could be drawn connecting the first transect to nearly the last transect.

During this period, the thermal bar remained within the area examined. In April (Cruise I) it stayed shoreward of the 4 km stations, dipping into and out of the shore. By May (Cruise II) it had advanced farther out, but in most cases to less than 8 km. Water warmer than 4°C was inshore; colder water less than 4°C was offshore. The highest values for the biomass of total phytoplankton and diatoms, particularly *Melosira binderana*, were observed in collections from the inshore side of the bar. This phenomenon may be related to the concentration of nutrients inshore and indirectly to temperature.

The July cruise (IV) showed less of a pattern. Biomass was generally low except for locations such as Station 223 where it increased to 2600 mg/m^3. Throughout this cruise high or low concentrations did not occur consistently at 1/2, 4 or 8 kilometer stations.

In the July-August cruise (V), again few trends were evident. Patches of high and low concentrations were scattered throughout the sampling area.

In September (Cruise VI) each station generally had a higher biomass than that observed during any of the other previous cruises. Also, the 4 kilometer station in each transect was higher in biomass than the 1/2 or 8 km station at either side.

During the September-October cruise (VII) biomass was generally uniform although there was slightly higher biomass inshore than offshore.

The October cruise (VIII) showed the widest range in biomass from station to station, both inshore to offshore and east to west. High concentrations were noted around the Genesee and especially the Niagara River mouths, while lower quantities were noted in the area between.

The November cruise (IX) showed a weak pattern inshore to offshore. Biomass was generally low and varied from station to station. The thermal bar was again forming during this cruise. The conditions indicating this were similar to those in the spring but were not as pronounced. Rodgers (1965) stated that the thermal bar forms in spring and fall with the fall not as well defined as in the spring. In the fall, however, the warmer waters are offshore of the bar, colder waters inshore. The phytoplankton data did not show as defined a biomass gradient as occurred during the spring thermal bar conditions, but a gradient was present.

During December (Cruise X) only Stations 201 through 210 were sampled. The biomass of these stations were low and there were too few collections upon which to draw any valid conclusions concerning distribution patterns.

A definite inshore-offshore pattern of biomass was not as evident in April 1973 as opposed to that observed in April 1972. Although collections from Stations 201, 231 and 243 had greater biomass than the 4-8 km stations, collections made at Stations 207, 213 and 222 had lower biomass than the 4-8 km stations. Biomass in the first three transects ranged lower (500-1000 mg/m^3) than the remaining four transects (700-5700 mg/m^3).

In early May (Cruise XII), although the thermal bar was present, it was not evidenced in the biomass. The samples taken at the 1/2 kilometer stations were lower or very close in biomass to the 4 kilometer samples. The samples collected at 8 kilometer stations were generally much lower (from 200-1200 mg/m^3) than those of the 4 kilometer samples.

The end of May (Cruise XIII) showed a moderate variation in biomass, the greatest values being 2200 mg/m^3 at Station 203, and the least (400 mg/m^3) at Station 243. In general, biomass did not vary greatly from station to station except for Stations 207 and 213, where samples collected yielded 800 and 900 mg/m^3 more than the 4 kilometer stations. By this time, the thermal bar had moved out of the area and apparently was not a factor in phytoplankton concentrations.

Phytoplankton Biomass-Horizontal Composition

In general, there was not significant differences among the percentage of species composition at 1/2, 4 or 8 kilometers in 1972 or 1973. The dominant taxa remained the same at all locations during each cruise. However, the percent composition and/or dominant taxa varied from cruise to cruise (Figures 6-8).

In April (Cruise I) diatoms accounted for over 50% of the biomass with Cryptophyta and Pyrrhophyta the next two major categories. In May (Cruise II), the diatoms remained the major group. However, the Pyrrhophyta increased to almost equal the diatoms in biomass. Unfortunately, a large gap occurred in the June collections (Cruise III) because a restricted schedule forced the omission of June phytoplankton sampling. In July

(Cruise IV) the diatom population had dropped to about 30% with the Cryptophyta in the majority and the Pyrrhophyta down to 4%. In the 1/2 and 4 kilometer stations, the nondescript flagellates (<5μ) began to make up 10 to 20% of the biomass. In July-August (Cruise V), the Cryptophyta increased to between 75 and 85% of the total biomass. At the 4 kilometer stations, the nondescript flagellates made up 12% of the biomass. Diatoms had dropped to 4%, nearly disappearing in the one meter samples. In September (Cruise VI), the Chlorophyta as well as the Pyrrhophyta rose to the highest quantities observed all year. This was largely due to the brief appearance of two large species, *Staurastrum paradoxum* (Meyer), a green alga (Desmidaceae), and *Ceratium hirundinella* (O.F. Müller), a dinoflagellate. The small nondescript flagellates diminished to 2% during Cruise VII in September-October. Pyrrhophyta constituted approximately the same percent biomass as in the previous cruise. Chlorophyta dropped to about 50% of its previous biomass. Both Cryptophyta and the diatoms increased, the former much more sharply than the latter. In October (Cruise VIII), the diatoms returned to comprise well over half the biomass while the Cryptophyta diminished. Pyrrhophyta and Chlorophyta also were found but in minimal amounts. The few samples analyzed from December (Cruise X) showed a continuing increase in the diatom population with the other groups declining.

When reviewing these group percentages, the total average biomass also should be noted (Figure 9). For example, if diatoms made up 50% of the biomass twice during the year, this does not necessarily mean that their actual numbers were similar during these two periods. Also when the Pyrrhophyta made up a large percent of the biomass, it does not necessarily indicate that the numbers were high. Dinoflagellates were large and it took less individuals to result in a higher biomass than any other group.

The April and May 1972 samples (Cruise I and II) consisted largely of diatoms - *Melosira binderana* Kuetzing, *Melosira islandica* var. *helvetica* O. Müller and *Stephanodiscus tenuis* Hustad. In the July and August cruises (IV and V) when the Cryptomonads dominated, *Cryptomonas erosa* Ehrenberg and *Rhodomonas minuta* Skuja were the dominant species. At this time *M. binderana* had nearly disappeared. In the July cruise, the tiny flagellates, *Katablepharis ovalis* Skuja and what we believe to be *Chrysochromulina parva* Lackey, appeared in large numbers at nearly every one meter station. This was especially the case with respect to the latter species.

In September (Cruise VI), there was a wide variety of Chlorophyta species. The most common member of this group was *S. paradoxum*. Other species that frequently occurred were various species of *Pediastrum*, *Coelastrum reticulatum* (Dang.)

Senn and *Coelastrum microporum* Naegeli, *Ankistrodesmus falcatus* (Corda) Ralfs and several species of *Scenedesmus*. In the September-October cruise (VII) where dinoflagellates dominated, a species of *Peridinium* and *Ceratium hirundinella* contributed to the biomass of the Pyrrhophyta.

In October (Cruise VIII), the dominant species again were *Cryptomonas erosa* and *Rhodomonas minuta* in the one meter samples. In November (Cruise IX), the diatoms dominated. However, this time the dominant species were *Stephanodiscus tenuis*, *Asterionella formosa* Hassall, *Fragilaria capucina* Desmazieres and *F. crotonensis* Kitton.

In December (Cruise X), the few samples that were taken and analyzed showed that fewer species were present. These were primarily diatoms. At that time, in addition to the species found in the last cruise, *Melosira islandica* ssp. *helvetica*, *Asterionella formosa* and *Tabellaria fenestrata* Lyngbye were also present.

For a complete list of species and groups to which each was assigned, refer to Table 7. For cell volumes of the most prevalent species encountered, refer to Table 8.

During the first spring cruise of 1973, diatoms were dominant. The prevalent species were *Melosira islandica* and *Asterionella formosa*. *Nitzschia vermicularis* Kuetzing, *Nitzschia acicularis* Kuetzing and *Nitzschia palea* Kuetzing appeared in small numbers. They, especially *N. acicularis*, became more prevalent in lower depths.

During the first cruise of April 1973 (Cruise XI), diatoms averaged 95% of the biomass at 1/2 kilometer and about 94% at 4 and 8 kilometer stations. The Cryptophyta composed the majority of the remainder of the biomass at all three points, with Pyrrhophyta and Chlorophyta each being responsible for less than 2% of the total biomass.

In early May (Cruise XII), diatoms were still dominant and responsible for over 70% of the biomass. Cryptophyta averaged about 25% of the biomass in samples collected at 1/2 and 4 kilometer stations and about 12% biomass at 8 kilometer stations. As in Cruise XI, Chlorophyta and Pyrrhophyta made up the remaining percentage of biomass. At the 8 kilometer stations, Pyrrhophyta rose to 10% of the biomass.

During the third and last cruise in late May 1973 (Cruise XIII), diatoms declined to 65% of the biomass, and the Cryptophyta increased to 29% in the samples collected at the 1/2 kilometer stations. Pyrrhophyta represented 4% and flagellates, which appeared in significant numbers for the first time that year, made up 2% of the biomass. In those samples collected at the 4 kilometer stations, Cryptophyta comprised 34% of the biomass: diatoms, 48%; Pyrrhophyta, 12%; others, 4%. Cyanophyta contributed only 1% of the biomass. In the 8 kilometer samples, Cryptophyta increased to 39% of the biomass while the diatoms dropped to 42% and Pyrrhophyta increased to 14%. The remaining biomass was comprised of Chlorophyta and others.

Phytoplankton Biomass-Vertical Composition

The following description is that of Transect I (Stations 222-224) and Transect II (Stations 231-233). This description refers to Diatoms (Bacillariophyceae), Cryptophyta, Pyrrhophyta, Chlorophyta, Cyanophyta and "Others" including flagellates and Chrysophyceae. Figures 10-17 display the groups that were dominant and by what percentages at each station and depth of Transect II (Stations 231-233) for the nine cruises of 1972.

During April and May 1972 (Cruise I and II), the diatoms comprised 50-96% of the biomass at all stations and depths, except for Station 233, 35 meters, where Pyrrhophyta dominated. In July (Cruise IV), the diatoms settled to lower depths and were found primarily in 20, 35 and 50 meter depths in both transects evaluated. Only 4% of the total biomass were diatoms in the upper waters (1 and 5 m) as compared to 95% in the lower depths (20, 35 and 50 m). In the July-August cruise (V), diatoms were again found (85-97%) but predominated at 35 and 50 meters in both transects. By September (Cruise VI) diatoms comprised the majority of the biomass in only 3 samples. These organisms were completely absent from the upper strata. In the September-October cruise (VII), diatoms again became prevalent at 20 and 35 meters at Stations 223 and 224 and 50 meters at Station 232. During October (Cruise VIII) samples in Transect I showed no diatom dominance. In Transect II, collections from 20, 35 and 50 meters at Station 232 as well as from 1 and 50 meters at Station 233 showed high diatom percentages. The November cruise (IX) showed diatom dominance in all but four samples. The December (Cruise X) samples indicated, at least at one meter, that diatoms made up more than 50% of the biomass.

The Cryptophyta did not show dominance until the July cruise (IV), in which they dominated the 1 and 5 meter collections at all stations. In August (Cruise V) all stations, except 232, showed Cryptophyta dominant in the 1 and 5 meter and at times 20 meter collections. In September (Cruise VI), the Cryptophyta were found only in the 1, 5 and 20 meter samples at Station 224. In the September-October cruise (VII), Cryptophyta concentrations dominated but other groups were close to these values. In the October cruise (VIII) this group dominated all the collections except two in Transect I (35 and 50 meters at Station 224), and all but four depths in Transect II which were previously mentioned to be dominated by diatoms. In the November cruise (IX), Cryptophyta were dominant in the 1, 5 and 20 meter samples at Station 224.

The Pyrrhophyta, comprised solely of the dinoflagellates (Dinophyceae), were present in April 1972 (Cruise I) but not to any appreciable extent except in the 35 meter collection from Station 233. They appeared again in September and October (Cruise VII) at scattered depths. In October-November (Cruise VIII), dinoflagellates were not dominant in any sample.

The "green" algae, Chlorophyta, did not appear in dominant percentages until September (Cruise VI). Collections taken at varying depths from both Transects I and II yielded large amounts of this group. In the September-October cruise (VII), the Chlorophyta were found dominant more often at lower depths (20-35 meters). During October (VIII) the greens were found in large amounts in collections from Station 224 at 35-50 meters.

At one point during the year it became necessary to include a group termed "Others". This group consisted of *Dinobryon* sp. and small (2-10 µ) unidentified flagellates. In the July cruise (IV), this group became prevalent due to a large number of the flagellates. In the 5 meter collections at Station 223 they comprised 60% of the biomass. In the July-August cruise (V), the 1 meter sample from Station 232 consisted of 63% of these flagellates. The only time the Cyanophyta ("blue-greens") became dominant was July-August (Cruise V) in the 5 and 20 meter collections from Station 232.

During the April cruise (I), it appeared that the phytoplankton were uniform throughout the water column since no depth was consistently higher in biomass than any other. The inshore (1/2 kilometer) stations did, however, yield an overall higher biomass than 4 or 8 kilometer stations at 1 meter. By May (Cruise II), the biomass figures were frequently well into the 1,000's of mg/m^3 especially in 1 and 5 meter samples. One and 5 meters generally ranked higher in biomass than 20, 35 or 50 meter samples. In August (Cruise IV), all but two stations displayed a higher biomass at 5 than at 1 meter. Values at 1 and 5 meters were generally lower than those of the previous cruise, except for Station 203 and 224, both of which had biomass values below 1,000 mg/m^3 in the May cruise. Total biomass did not vary greatly from the July cruise (IV) to the July-August cruise (V). During September (Cruise VI), the biomass again increased to 1,000's of mg/m^3, especially in the 1 and 5 meter collections. Values in the samples below 5 meters dropped considerably. September-October (Cruise VII) values were again lower than the previous cruise. Values reached over 1,000 mg/m^3 only in the 1 meter samples at Station 231 and 243. The November (Cruise IX) biomass decreased again from the previous cruise and in both these cruises biomass was again dispersed throughout the water column.

In the April cruise of 1973, biomass remained dispersed throughout the water column as in April 1972 and within the same range of values.

In detail, the succession and abundance of the phytoplankton species for 1972-1973 was as follows. The April and May 1972 samples consisted largely of the diatoms *Melosira binderana* Kuetz., *Melosira islandica* ssp. *helvetica* O. Müller and *Stephanodiscus tenuis* Hustedt, in that order. The higher concentrations of *M. binderana* were observed in May (1800-1900 mg/m^3). *M. islandica* was found inshore (1/2 km) in April and offshore (8 km) in May. The Dinoflagellate, *Peridinium aciculiferum* (Lemm.) Lindem, also was prevalent, especially at Stations 231, 232 and 233 during May.

Cryptomonas erosa Ehrenberg, a Cryptomonad found throughout the year, became the dominant species in the 1 and 5 meter collections of Cruises IV and V (July and August), as well as in the 20 meter samples at Stations 224 and 233. In the 35 and 50 meter collections, *M. islandica* was dominant. *M. binderana* had almost disappeared at this time.

During August at Station 223 (5 meters), Station 224 (20 meters), and Station 232 (1 meter), the phytopflagellates were dominant for the only time during the 1972-1973 sampling period. Large amounts of what we believe to be the small flagellate, *Chrysochromulina parva* Lackey, were found. Due to low amounts of other species, *Oscillatoria limnetica* Lemmermann, a blue-green alga, became the highest contributor to biomass in 5 and 20 meter collections from Station 232. Because of their small size, the Cyanophyta encountered in this study usually contributed little to biomass except during late summer. This was their only major appearance.

The September cruise showed an increase in the Chlorophyta, especially *Staurastrum paradoxum* Meyen. This species was the main contributor when the greens were dominant. Also contributing to the Chlorophyta biomass were *Cosmarium formosulum* (Hoffman) and various species of *Scenedesmus*, *Pediastrum*, and *Coelastrum*. They were present in varying amounts throughout the cruise. *Ceratium hirundinella* O. F. Müller and a species of *Peridinium* also added to the Pyrrhophyta dominance in September. *Cryptomonas erosa* and *Rhodomonas minuta* Skuja again made up the majority of the Cryptophytes that appeared.

In the October cruise, the same species made up the majority of the biomass as in the previous cruise. *Fragilaria crotonensis* Kitton and *F. capucina* Desmazieres contributed to the diatom biomass in the deeper samples.

In October, *Cryptomonas erosa* domirated almost completely except for 3 deep samples from Station 232 where diatoms dominated. These diatoms were mainly *Fragilaria capucina*, *F. crotonensis* and *Tabellaria fenestrata* Lyngbye. *T. fenestrata* and *Stephanodiscus tenuis* were observed in the 1 meter sample at Station 243. The Chlorophyta were found in the 35 and 50 meter samples at Station 224.

In November, diatoms dominated all stations but one (Station 223). The diatoms that were most common throughout the majority of the collections were *Stephanodiscus tenuis*, *Tabellaria fenestrata*, *Asterionella formosa* Hassall and *Fragilaria crotonensis*. *Synedra acus* (Nitzsch) Ehrenberg appeared in this cruise in small numbers except in the 1 and 50 meter samples at Station 238, where there were 76 and 42 cells/ml, respectively.

In December, the species composition was like that of the previous cruise.

In the first spring cruise of 1973 (Cruise XI), the dominant species at all depths were *Asterionella formosa* in number and *Melosira islandica* in biomass. *Asterionella* was found up to 645 cells/ml with a biomass of 300 mg/m^3 in the one meter sample from Station 222. As an example of the predominance of *M. islandica*, at Station 223 the collection at 35 m had 204 cells/ml and a biomass of 728 mg/m^3.

Melosira islandica and *Asterionella formosa* were again the dominant species during Cruise XII. They did not reach the high numbers at any one particular station as in the previous cruise. However, biomass was consistently higher throughout the sampling area. The Pyrrhophyta species that prevailed at this time were *Gymnodinium helveticum* Penard and an unidentified Dinoflagellate which were not found in high numbers but had large individual cell volumes.

The species having the largest amount of biomass during the third cruise in May of 1973 was again *Melosira islandica*, the second and third highest *Cryptomonas erosa* and *Rhodomonas minuta*. The largest amount found throughout the cruise was collected at Station 213. Here *M. islandica* reached 267 cells/ml totaling 389 mg/m^3. *Cryptomonas erosa* was found in moderate, yet consistent, numbers throughout the May cruise.

Phytoplankton Biomass-Distribution and Composition-River Mouths

The following are the results of analyses of Stations 363, 364, 365, 367, 369, 370, 372, 375, 392, 383, 385 and 386 at the Niagara River mouth (Figure 3).

The first cruise (June) was generally low in biomass. The highest biomass, 1129 mg/m^3, was observed in three collections from Station 370 where the river enters the lake. The average biomass during this cruise at 1 meter was 722 mg/m^3.

The important species during this cruise were *Cryptomonas erosa* Ehrenberg, *Melosira binderana* Kuetzing and *Rhodomonas minuta* Skuja, in that order. There was no evident pattern according to depth.

In mid-June (Cruise III), the biomass appeared lower than the previous cruise, possibly because of the declining numbers of *Melosira binderana*. The main species were *Cryptomonas erosa*, *Rhodomonas minuta*, and the Flagellates which became prevalent in the lake during July. The average biomass at 1 meter was 576 mg/m^3 for this cruise.

During Cruise IV in late August, the biomass became quite high due to the presence of *Staurastrum paradoxum* Meyen and *Ceratium hirundinella* O. F. Müller, both of which had high individual cell volumes. The values on the collections from all stations were over 1500 mg/m^3. The highest biomass was found at Station 374 directly at the river mouth. The mean of the biomass for the 1 meter collection from all stations was 2295 mg/m^3.

During the December cruise (VI), the biomass ranged from 615 mg/m^3 at Station 365 to 2735 mg/m^3 at Station 364; the mean biomass at 1 meter was 1334 mg/m^3. The samples were numerically dominated by *Cryptomonas erosa* and by *Stephanodiscus niagarae* Ehrenberg in biomass. *Tabellaria fenestrata* Lyngbye and *Asterionella formosa* Hassall were next in biomass dominance.

There was no apparent relationship between depth and biomass in any of these cruises. Samples taken below 1 meter were found at times to be lower and at other times higher than the 1 meter collections.

Analyses of samples gathered during May of 1973 (Cruise VII) produced a wider variety of species when compared to spring 1972 (Cruise I) samples. In 1973 major species were *Cryptomonas erosa*, *Rhodomonas minuta*, *Melosira islandica* ssp. *helvetica* O. Müller, and *Tabellaria fenestrata* Lyngbye. The highest biomass during this cruise was yielded by the sample collected at Station 363, 1080 mg/m^3; the lowest from Station 374, 700 mg/m^3. The average biomass was 820 mg/m^3, slightly higher than May of 1972.

With reference to the Genesee River mouth, during the May cruise (I) the highest biomass was found at Station 352, closest to the mouth, which amounted to 3496 mg/m^3. Biomass was fairly high at this time. The lowest biomass was found at Station 356

(1823 mg/m^3). The mean biomass in the 1 meter collections was 2889 mg/m^3. *Melosira binderara* made up the majority of the biomass while *M. islandica*, *Cryptomonas erosa*, and *Rhodomonas minuta* also were abundant.

During the mid-June cruise (V), the average biomass at 1 meter was 1965 mg/m^3. The highest biomass, 2993 mg/m^3, was found at Station 362, the station farthest north. Although the numbers were lower than that of the previous cruise, *Melosira binderana* was again the dominant species. *Cryptomonas erosa* and *Rhodomonas minuta* were also prevalent. The other diatoms began to decline in number.

A wide range in biomass was noted during the August cruise (VI). The lowest amount found in the 1 meter collections was observed at Station 352 (312 mg/m^3); the highest at Station 356 (3594 mg/m^3). The only diatom encountered consistently was *Fragilaria crotonensis*, which was present in small amounts. The most abundant species were *Cryptomonas erosa*, *Rhodomonas minuta* and *Peridinium* sp. The latter often contributed significantly to the biomass. Flagellates also were found in high numbers during this cruise. The mean biomass at 1 meter was 1394 mg/m^3.

During the late November cruise, the highest biomass found was at Station 362 (768 mg/m^3), the lowest at Station 352 (58 mg/m^3). The mean was 500 mg/m^3. This cruise had the lowest average biomass of all the Genesee River mouth cruises analyzed. *Cryptomonas erosa* was the most common species. *Tabellaria fenestrata* was the second highest species in biomass, with *Asterionella formosa*, *Stephanodiscus tenuis* Hustedt, and other diatoms contributing to the biomass. Again, there was no apparent relationship between depth and biomass except for June (Cruise V) during which biomass consistently decreased as depth increased.

During the mid-May cruise (IX) of 1973, biomass at 1 meter ranged from 860 mg/m^3 in collections from Station 356 to 2220 mg/m^3 at Station 353. The average biomass was 1330 mg/m^3, less than half the average biomass of the previous spring. The predominant species were *Melosira islandica*, *M. binderana*, and *Cryptomonas erosa*, in that order. Biomass and cell number values were within a narrow range.

Thermal Bar Effects

During April and May 1972, the thermal bar was confined within the 45 nearshore stations (Figure 4) making it possible to observe the possible effects temperature had on the phytoplankton population as spring progressed and the waters warmed. There was a strong relationship between the location of the thermal bar and the amount of biomass present. The Pearson correlation coefficients for total phytoplankton biomass and temperature at 1 meter were 0.82 and 0.78, respectively, which indicates a significant correlation at the 95% confidence level. The greatest concentration of phytoplankton for individual species and total cell numbers was contained in the waters on the shoreward side of the bar for these two months (Figure 5).

The total phytoplankton biomass followed bathymetric and temperature contours, decreasing with distance from shore (Figure 5). The area on the side of the bar towards the center of the lake remained at less than 1000 mg/m^3 even as the bar shifted offshore in May. The thermal bar appeared to act as a barrier for phytoplankton production beyond 1000 mg/m^3 outside the bar. Shoreward of the bar the biomass ranged from 1000 to 7000 mg/m^3. In both April and May some of the lowest concentrations of biomass were observed around the Niagara River plume, where in April they were as low as 100 mg/m^3. Four species most dominant during this period were *Melosira binderana* Kuetzing, *Peridinium aciculiferum* (Lemm.) Lindem, *Surirella angustatum* Kuetzing and *Rhodomonas minuta* Skuja. Their highest concentrations also were on the shoreward side of the bar. Figure 5 like that of *Melosira binderana* demonstrates the general effect for three species of the four. *M. binderana* followed the movement of the thermal bar most closely and had the strongest gradient. These findings are in agreement with those of Munawar and Nauwerck (1971) and Munawar and Munawar (1974b).

Zooplankton

The seasonal distributions of total zooplankton in the Lake Ontario nearshore zone were similar at the 4 and 8 km stations (Table 9) with the former sustaining somewhat higher concentrations than the latter. Collectively the 8 km stations were bimodal in 1972 with peaks in June and October. The 4 km stations also peaked at those times plus exhibited an additional pulse in early September from which the decline was small. The density of total zooplankton at the 1/2 km stations was about the same as for the 4 km stations through June 1972, but then increased markedly to a single extremely high maximum lasting through the two September cruises. By September (at the six stations sampled) the zooplankton was still more abundant than it had been in the spring probably because the copepods had not yet reached their low winter levels. The three spring 1973 cruises differed from the two spring 1972 cruises in several ways (Table 10). The spring 1973 total zooplankton was 4 times higher at 1/2 km, 2.2 times higher at 4 km and about 1.75 times higher at 8 km than in spring 1972. Much of the differences were due to higher concentrations of nauplii in spring 1973. The population levels at 4 and 8 km from shore were about the same at the time of the first sampling in April in both 1972 and 1973; there was considerably more zooplankton at 1/2 km from shore at this sampling time in 1973 than in 1972. In spring 1973, especially at 1/2 and 4 km from shore, there was much more zooplankton present during the middle cruise than during the other two, again due largely to higher concentrations of nauplii.

The average concentration of total zooplankton during 1972 and spring 1973 was 40,963/m^3 at the 1/2 km stations, 13,744/m^3 at the 4 km stations and 7251/m^3 at the 8 km stations. Since the average depths at these stations were 5.0 m, 40.1 m, and 91.9 m, respectively, the average zooplankton numbers occurring under a square meter of surface area were 204,815/m^2 at the 1/2 km stations, 551,134/m^2 at the 4 km stations, and 66,367/m^2 at the 8 km stations. Therefore, even though the 1/2 km stations usually had higher concentrations of zooplankton per cubic meter, the deeper stations, those at 4 and 8 km from shore, generally sustained more zooplankton under a square meter of surface area.

The seasonal abundances of cladocerans, cyclopoid copepodids, calanoid copepodids, and copepod nauplii each expressed as a percentage of total zooplankton at 1/2 km, 4 km and 8 km from shore are illustrated in Table 11. At all three distances from shore, calanoid copepodids constituted an insignificant part of the total zooplankton (average for entire study 1-3%), but in 1972 they were slightly more abundant in spring and fall. In 1972, as expected, cladocerans comprised a small percentage of all zooplankton in spring and late fall at all stations and dominated from mid-summer through early fall at the 1/2 km stations with up to 64% of total zooplankton. They were relatively less important at the 4 and 8 km stations. In spring 1973 some caldocerans were present, but at a level of less than 1% of the total zooplankton. Cyclopoid copepodids increased moderately in relative abundance with increasing distance from shore. In 1972 they accounted for a lesser portion of the total zooplankton from mid-July through late September than during the rest of the year. Cyclopoids were relatively less important in spring 1973 than in spring 1972 due again to the preponderance of nauplii in spring 1973. Nauplii represented about the same percentage composition (42-46%) at 4 and 8 km from shore and a smaller fraction (30%) at 1/2 km from shore. They exhibited similar patterns of relative abundance from April through mid-July 1972 and in spring 1973 at all three distances from shore, although the percentage was higher in spring 1973 than in spring 1972 and highest (80%) at 1/2 km from shore at these times. From late July through November nauplii comprised a larger proportion of total zooplankton at 4 and 8 km from shore than at 1/2 km, yet even at 1/2 km, nauplii accounted for at least 30% of the total zooplankton. In December nauplii were relatively least important at the 8 km stations but there they still comprised one-quarter of all zooplankton, indicating that copepod reproduction was still continuing quite late in the fall in the whole study area. These data demonstrate that copepod nauplii constitute a significant portion of the zooplankton community. However, in reality, nauplii are almost certainly more abundant than these values indicate because even the fine 64μ mesh net used in this study does not retain all nauplii (McNaught and Buzzard 1973).

Forty-one identification groups were encountered during the entire study (Table 12). Of these, 17 groups were Cladocera and 24 were Copepoda. At 1/2 km from shore there were 36 identification groups present during 1972 and 39 during the entire study period. At 4 km there were 33 groups in 1972 and 36 in 1972 and spring 1973. At the 8 km stations there were 24 identification groups encountered from the 1972 samples with no additional species occurring in the spring 1973 samples. Most of the species which were not encountered at the 8 km stations are rare benthic-littoral forms.

The nine most commonly occurring zooplankters in the entire study area are discussed below in decreasing order of their importance. Some less common species, i.e. adult calanoids, are also discussed. These species are believed to be new records for Lake Ontario. Species not specifically mentioned generally occurred sporadically and in low numbers. Table 12 illustrates the seasonal distributions of all identification groups encountered in the study using the average numbers per cubic meter during each of the 13 cruises at each distance from shore. Table 13 illustrates the spatial distribution of zooplankton for the first, second and third highest concentrations at a single station for a single time.

Copepod nauplii comprised the most abundant identification group in the entire study area. In 1972, with the exception of the 4 km stations in December, their numbers were lowest in spring and late fall, although nauplii were still present in appreciable numbers even then. In spring 1973 there were considerably more nauplii in April and mid-May at 1/2 km and in mid-May at 4 and 8 km than in spring 1972. At 4 and 8 km from shore the total zooplankton numbers excluding nauplii were about the same in spring 1972 and spring 1973. At 4 km nauplii were 3.3 times more abundant in spring 1973 and at 8 km they were 2.2 times more numerous than in spring 1972. Because the duration of each naupliar instar, and particularly of NI-NIII, is probably quite short (Robertson et al. 1974), it is possible that the sampling at most of the stations in mid-May 1973 at 4 and 8 km occurred just at the time when a new, but not necessarily more numerous, generation of copepods was in the naupliar stages; perhaps there really was greater copepod reproduction in spring 1973 than in spring 1972. Because sampling was terminated at the end of May 1973 and also because water masses do not remain stationary (Davis 1962) and zooplankton is not homogeneously distributed, it is impossible to determine whether there was really a difference in copepod levels at 4 and 8 km from shore between the springs of 1972 and 1973. The same arguments may apply to the 1/2 km stations, however the occurrence of more immature cyclopoid copepodids in spring 1973 as well as more nauplii suggests probably there were higher levels of copepods then than in spring 1972. Because cyclopoid copepodids were far more abundant than calanoid or harpacticoid copepodids, it may be assumed that the distribution of nauplii described above is in large part that of cyclopoid nauplii and in particular, of the two dominant cyclopoids, *Cyclops bicuspidatus thomasi* and *Tropocyclops prasinus mexicanus*.

Bosminids with mucro comprised the second most abundant identification group in the entire study area, accounting for 24.7% of all zooplankton; it was the predominant group at the 1/2 km stations. At 1/2 km there was one very high peak which occurred in early September, but the population was still quite high by the end of the month. At 4 and 8 km bosminids with mucro were not nearly so abundant and exhibited two pulses, one in early September and the other in October. At all locations this group was present in low numbers in spring and late fall. Although bosminids are small cladocerans, Wilson and Roff (1973) report their average dry weight as only about 20% less than that of *Daphnia retrocurva*, a large cladoceran. Hence at the 1/2 km stations bosminids with mucro should be dominant not only numerically, but in terms of biomass as well.

Immature cyclopoid copepodids were the third most abundant identification group, comprising 22.7% of the total zooplankton. This group exhibited three pulses, the first in June, the second in early September from which the decline was small, and the third in October when the maximum at each distance from shore occurred. Appreciable numbers of immature cyclopoid copepodids in late fall indicate that cyclopoid development was still occurring then. In fact, 23-32% of all cyclopoids were only in the early copepodid stages (CI-CII) in December. Likewise, moderate levels of this group in the spring of both years suggest that reproduction probably began in late winter as others have found (Davis 1961; Schindler and Noven 1971). During the first cruise each year 23-44% of all cyclopoids were already late immature copepodids (CIII-CV). Of the two dominant cyclopoids, *Tropocyclops prasinus mexicanus* was not present in appreciable numbers until at least mid-summer, hence in April probably most of the immature cyclopoid copepodids, and certainly the older ones, were *Cyclops bicuspidatus thomasi*. Because adults of both the dominant species were common in the fall, the immatures were most likely bi-specific also.

Daphnia retrocurva, the fourth most common species, was not detected until mid-July 1972 but was present in minimal numbers in April and May 1973. The maximum numbers at all stations were noted in late September. The highest numbers were obtained at the 1/2 km stations. In December there were not many *D. retrocurva*, but at Station 210 one-quarter of those present were gravid. There were males at two-thirds of the stations in October and all but three stations in November. Developing ephippia were present at two stations in October, 9 stations in November, and two stations in December.

Ceriodaphnia lacustris, fifth most common, was essentially absent from April through mid-July 1972, in November and December, and in spring 1973. At the 1/2 and 4 km stations the population peaked in early September and remained nearly as high through the month. At 8 km the maximum was in October. Developing ephippia were noted in *C. lacustris* at one station in late September and at two-thirds of the stations in October. Males were seen at two stations in October.

Although *Cyclops bicuspidatus thomasi* was only the sixth most abundant identification group in the entire study area, it was the most common adult copepod. This species had somewhat different distribution patterns at each distance from shore in 1972. At the 1/2 km stations there was a steady decrease through mid-July 1972 and through the end of the sampling period in May 1973 from winter - early spring population levels. The maximum was in late September. At 4 km from shore there were two pulses, one in June and the other coinciding with the peak at 1/2 km. At 8 km from shore the population fluctuated through July then peaked in early September 1972. At both 4 and 8 km from shore, as at 1/2 km, the populations declined from moderate levels during the three spring 1973 cruises.

Tropocyclops prasinus mexicanus, seventh, remained at low densities into July 1972 and in spring 1973 at all distances from shore. By late July at the 1/2 km stations this species began to increase towards its rather high maximum in late September. At 4 and 8 km from shore it was early September before *T. prasinus mexicanus* registered a significant increase in population levels. The maxima at 4 and 8 km occurred in October.

Immature calanoid copepodids, eighth, ranged between 50 and 100 per cubic meter through late July 1972 at the 4 and 8 km stations. They were slightly more abundant in spring 1973 than spring 1972. The peak at 4 km was in November and at 8 km it was in October. At the 1/2 km stations immature calanoid copepodids began to increase in number before mid-July, reaching a maximum in early September. In fall 1972 all stages of copepodids of all the species were represented with probably only a slight predominance of the older stages. In November most of the species were still breeding, so if the new generations were successful, there would be immature calanoid copepodids into at least early winter.

Eubosmina coregoni, ninth most common, occurred in very low numbers until fall 1972 and in spring 1973 with the exception of a June 1972 pulse at 1/2 km attributable to a bloom only at Station 243. Only in November was this species encountered at all stations. At the 4 km stations the pulse was in November. At the 8 km stations it was in October. The seasonal distributions of *E. coregoni* and bosminids with mucro seem to be somewhat complementary. Parthenogenic reproduction was still occurring in November and December.

Daphnia galeata mendotae, eleventh, followed the familiar cladoceran pattern of absence until mid-summer. At the 1/2 km stations the maximum occurred in late September; at the 4 km stations the population was at its highest in December with a surprising 383/m^3. There were males at one station in November.

Eight species of adult calanoids were identified during the study. *Diaptomus oregonensis*, tenth most common of all identification groups, was either absent or present in low numbers until September 1972 and in spring 1973. Its greatest concentrations were in late fall. *Diaptomus minutus*, twelfth most abundant of all identification groups, was the second most important calanoid. Unlike *D. oregonensis*, it was generally evenly distributed throughout the year occurring in moderately low densities. *Eurytemora affinis*, thirteenth, was present from summer through November at low densities except at 1/2 km where the population averaged 269/m^3 in November. *Limnocalanus macrurus*, fourteenth, occurred throughout the sampling period at 8 km with its greatest concentration in November. *L. macrurus* was present during less than half the cruises at 4 km from shore. Because it is a deep, cold-water form, it is not surprising that it was essentially absent at the 1/2 km stations. *Diaptomus sicilis*, fifteenth, is also a deep, cold-water species which was present only at 1/2 km when the water was cold (at 2 stations in April 1972, 3 in November, 1 in April, and 1 in late May 1973). *D. sicilis* was most abundant in the fall at 4 and 8 km from shore with higher concentrations at 8 km. *Diaptomus siciloides* occurred infrequently at low concentrations. Contrary to its apparent usual habitat preference of warm summer waters (Czaika and Robertson 1968), *D. siciloides* was found in October and November at 1/2 km, in November and December at 4 km and in November (3 stations) and early May 1973 at 8 km. It was still breeding in November. The two *Diaptomus* species which have recently been reported from Lake Ontario for the first time (Robertson 1966), *D. ashlandi* (McNaught and Buzzard 1973) and *D. pallidus* (Patalas 1969), were both detected in very low numbers. *D. ashlandi* was present at Stations 207 and 231 in April 1972 and at Station 214 in April 1973. It was breeding in April 1973. *D. pallidus* was encountered at Station 207 in late September and Station 208 in November.

Several species were encountered which have not been reported from Lake Ontario before. Of the new record cladocerans, several species of *Alona* were encountered [perhaps *A. costata* (Sars), *A. guttata* (Sars), and *A. quadrangularis* (O. F. Müller)]. *Camptocercus rectirostris* (Schodler) was found at Station 237 in June and mid-July, Stations 207, 208, 231 in late July, and Station 243 in late September. It reached a maximum of 1792/m^3 in mid-July. *Eurycercus lamellatus* (O. F. Muller) was present at Station 207 in late July. The cyclopoid *Eucyclops* (perhaps *E. prionophorus* (Kiefer) which could have been accidently introduced into Lake Ontario via the Genesee River) was found at two Stations, 243 and 244, off the Genesee River mouth in May 1972. All seven species of harpacticoids encountered are new records for Lake Ontario. *Bryocamptus nivalis* (Willey) was found at Station 238 in April 1972. *Canthocamptus robertcokeri* (M. S. Wilson) was present at Stations 208, 213, 231, 244 in April 1972; 202, 243, 244 in May 1972; 201 in June; 207 in mid-July; 231 in April 1973; and 202, 223 in early May 1973. Its maximum abundance was 185/m^3 in June. *Canthocamptus staphylinoides* (Pearse) occurred at Station 201 in June; 222, 231 in April 1973; 202 in early May 1973; and 222, 237 in late May 1973. Its greatest concentration (417/m^3) was at a single station in June. *Mesochra alaskana* (M. S. Wilson) occurred at Station 237 in June and 202 in April 1973. *Moraria cristata* (Chappius) was from Station 231 in April 1972. Two species of *Nitocra* were first found in the spring 1973 samples; *N. hibernica* (Brady) was from Station 213 in early May and *N. spinepes* (?) occurred at Station 237 in late May.

Some of these new records are for species that have been identified from other of the Great Lakes and some are of additional species of genera reported from other Great Lakes. Some examples follow. Of the cladocerans, Wells (1960) first reported *E. lamellatus* from Lake Michigan. Roth and Stewart (1973) reported *E. lamellatus* and *Alona* spp. from Lake Michigan. Leach (1973) reported *A. costata*, *A. intermedia*, *A. quadrangularis*, *C. rectirostris*, and *E. lamellatus* from Lake St. Clair. Davis (1962) found *Camptocercus* sp. and *Eurycercus* sp. in Lake Erie at Cleveland Harbor. Bradshaw (1964) first reported *E. lamellatus* from Lake Erie. Patalas (1972) has reported *E. lamellatus* from Lake Erie as have Rolan et al. (1973) and Watson and Carpenter (1974). Watson and Carpenter (1974) also listed *A. affinis* from Lake Erie. The cyclopoid *Eucyclops agilis* has been identified from Lake Michigan (Roth and Stewart 1973) and from Lake Erie (Rolan et al. 1973; Watson and Carpenter 1974). Watson and Carpenter (1974) also reported *Eucyclops speratus* from Lake Erie. Of the harpacticoids, *Canthocamptus* sp. has been reported from Lake Michigan (Roth and Stewart 1973) and *C. robertcokeri* from Lake Erie (Davis 1962; Rolan et al. 1973). *C. staphylinoides* was reported from Lake Erie by Chandler (1940) and by Davis (1954). However, both studies pre-dated Wilson's (1958) description of the similar, new species *C. robertcokeri*. Wilson (1958) determined that Davis' (1954) so-called *C. staphylinoides* was *C. robertcokeri* and used Davis' (1954) animals as type lot for the new species. It is, of course, possible that Chandler's (1940) specimens may also have been *C. robertcokeri*.

During this study, variation invalidating the key character for separating *C. robertcokeri* and *C. staphylinoides* (Wilson and Yeatman 1959) was observed. However, differences between the two species other than Wilson and Yeatman's (1959) were discovered (Czaika 1974). Czaika (1974) also presents a short key for determining the number of each of the first four pairs of swimming legs on adults of these two species to use if the legs become mixed-up during dissection and mounting.

All of the new records reported herein are of benthic-littoral forms rather than true planktonic species. Undoubtedly there will be more new records from Lake Ontario as the detailed IFYGL data become available and as more detailed studies are conducted, particularly of nearshore waters.

There were more differences than similarities in zooplankton between the Genesee and Niagara River mouth areas. There was more zooplankton at the Niagara River mouth during all cruises except late August and then the difference was not great (Table 14). Zooplankton during the five cruises was 5.5 times more abundant at the Niagara River mouth area than at the Genesee. With three exceptions, the same zooplankters were common at both areas (Table 14). *Tropocyclops prasinus mexicanus* was common at the Genesee River mouth and not at the Niagara. *Diaptomus oregonensis* was common only at the mouth of the Niagara River. The common daphnid at the Genesee River mouth area was *D. retrocurva*; at the Niagara River mouth it was *D. galeata mendotae*. Copepods were most abundant in spring at the Niagara River and later in the season at the Genesee River. There was more zooplankton in the spring of 1972 than in the spring of 1973 at the Niagara River mouth and less in spring 1972 than in the spring of 1973 at the Genesee River mouth. At the latter area there were only two common zooplankters in the spring, nauplii and immature cyclopoid copepodids. At the former area, in addition to these two identification groups, there were appreciable numbers of immature calanoid copepodids in spring 1973 and *Cyclops bicuspidatus thomasi* and bosminids with mucro in spring 1972. It is surprising there were so many bosminids at the Niagara River mouth in spring 1972 since they are usually scarcely detectable at this level of sampling in the spring.

The seasonal distribution of zooplankton at the Genesee River mouth (Table 14) generally followed the same pattern as in the nearshore region of southwestern Lake Ontario, with maxima for most major identification groups as well as total zooplankton in late summer-early fall. At the Niagara River mouth area total zooplankton was most abundant in late spring. In late May-early June nauplii (77,843/m^3) accounted for 84% of the total zooplankton. In mid-June nauplii (56,642/m^3) comprised 42% of all zooplankton; immature cyclopoid copepodids were unusually numerous accounting for 44% of total zooplankton. A majority of the immature cyclopoids were in the early copepodid stages. Despite the river mouth currents, these data suggest that in mid-June the same, although more mature, populations were being sampled as were sampled in late May-early June. Copepod numbers were unusually low in late August at the mouth of the Niagara River.

Two zooplankton species which have not been reported previously from Lake Ontario were encountered in the river mouth portion of the study. One was the harpacticoid *Bryocamptus zschokkei* (Schmeil). It was found at Station 352 at the mouth of the Genesee River in November. The other was the harpacticoid *Epactophanes richardi* (Mrazek) which occurred at Niagara River Station 375 in December.

It is interesting to note that five new record species reported by Czaika (1974b; above) also occurred in the river mouth areas. The harpacticoid *Canthocamptus robertcokeri* was from Genesee River Stations 353 and 355 (plus three stations not routinely included in this study) in late May-early June 1972 and from Stations 353 and 356 in May 1973. The harpacticoids *Canthocamptus staphylinoides* and *Nitocra hibernica* were from Niagara River Station 363 in December, and from Niagara River Station 375 in August, respectively. The cyclopoid *Eucyclops prionophorus* (?) was encountered at Genesee River Station 352 in late May-early June 1972 plus at Station 351 which was not routinely included in this study. The species is considered a river species (Wilson 1959) and was encountered in Lake Ontario only at stations off the Genesee River (243, 244). The cladoceran *Camptocercus rectirostris* was found at Niagara River Station 269 in August. The cladoceran *Macrothrix laticornis*, first reported from Lake Ontario by McNaught and Buzzard (1973), was found at Genesee River mouth Station 352 in November. A few macrothricids were encountered in the Lake Ontario segment of this study. They were tentatively identified as *Macrothrix hirsuticornis* (Norman and Brady), although due to a degree of uncertainty the species has not been reported to date by this author.

In the Niagara River mouth area, Station 369 supported the most zooplankton. Total zooplankton, total copepods, immature cyclopoid copepodids, *Cyclops bicuspidatus thomasi* and *Daphnia retrocurva* were most abundant at this station. Total zooplankton was 2.2 times higher than at the station with the second highest concentration. Nauplii accounted for 74% of the total zooplankton, yet if nauplii are excluded, copepods were 20% more numerous at the station with the second greatest abundance of copepods and 3.7 times more numerous than at the station with the fewest copepods (excluding nauplii). Bosminids with mucro were most numerous at Stations 379, 383 and 386, comprising 95 to 98% of all cladocerans at these stations. They increased in abundance with increasing distance from the river mouth.

At the Genesee River mouth the greatest abundance of total zooplankton occurred at Station 356 with bosminids with mucro accounting for 50% of the total. The second highest concentration of zooplankton was at Station 359; copepods comprised 73% of the total largely because the highest concentrations of nauplii, immature cyclopoid copepodids, and *Tropocyclops prasinus mexicanus* occurred there. Generally, more zooplankton was found farthest from shore in the Genesee River mouth sampling area, suggesting more favorable conditions for zooplankton a bit away from the direct flow of the river channel.

Benthos

Species lists giving number of organisms per m^2 per station are presented in Tables 15-19. The mean numbers of the major taxa for the 5 samplings are presented by percentages for each station in Table 20. The dominant taxa noted during the survey were the Tubificidae (47.2%), the Sphaeriidae (23.7%), *Pontoporeia affinis* (15.1%) (Amphipoda), and *Stylodrilus heringianus* (11.0%) (Lumbriculidae). None of the other taxa amounted to more than 1% of the total macroinvertebrates for the survey.

Figure 18 shows the average percentage of Oligochaeta to the average number of macroinvertebrates per station. Figure 19 shows the average percentage of Tubificidae to the average number of macroinvertebrates per station.

Stations 208, 209, 214 and 245 contained mean macroinvertebrate counts which were considerably greater than the other stations examined. The percentage of Tubificidae to total macroinvertebrates noted per station per cruise is given in Figures 20-24. In general, Stations 208, 209, 214 and 245 were high in both macroinvertebrates and in the percentage of Tubificidae. During the first cruise in 1972, Stations 202 and 203 showed large numbers of total macroinvertebrates, with Station 202 containing a high percentage of Tubificidae. Station 224 contained a relatively high percentage of Tubificidae during Cruises I (April-May), III (June) and VI (September) as compared with neighboring stations.

Figures 25-28 show the mean percentage of Sphaeriidae, *Pontoporeia affinis*, *Stylodrilus heringianus* and *Limnodrilus hoffmeisteri* to the mean number of total macroinvertebrates per station, respectively.

Other than the 4 taxa already mentioned, the only time an individual taxa represented more than 10% of a sample was on Cruise III when *Mysis relicta* constituted nearly 60% of the total count at Station 215. At Station 244 *Gammarus fasciatus* was the dominant Amphipoda and appeared in each sample taken at that station, usually in fair numbers (mean 619/m^2).

Cladophora

Cladophora samples were collected on seven (7) occasions between 20 June 1972 and 15 May 1973. The dry and ash-free dry weight results are shown in Tables 21-27. From these data, the observed peaks in ash-free dry weight occurred in early July and late October. However, with respect to these as well as other findings for this attached plant, the *Cladophora* exhibited a patchy growth pattern throughout the study area. Where a suitable substrate (i.e. limestone) was present, attached algal growth was abundant. Where sand was found, no growth was observed. Therefore, in areas where rocks emerged from the sand, either abundant or no material could be gathered at a particular depth depending on whether the randomly tossed hoop fell over a sandy or rocky region.

With regards to the June 1972 results, there was a definite west to east increase in *Cladophora* biomass. The highest biomass was noted at 4 m along Transect 237.

By mid-July the highest quantities were observed in the central sector of the collection region. The highest biomass was noted at a 3 m depth along Transect 216.

The late July sampling yielded distribution results similar to those observed in June. The maximum biomass was found at 5 m along Transect 217.

The lowest *Cladophora* was observed during mid-August. The high variability in the data may have been due in part to the tearing loose of this alga from the substrate.

The maximum ash-free dry weight was noted at 5 m along Transect 207. The highest mean ash-free dry weights per sampling period (8.73 g/m^2) was noted in mid-October. The largest *Cladophora* quantities occurred along Transect 207, near the Niagara River mouth.

During May 1973 the highest *Cladophora* quantities were collected near the Niagara and Genesee River mouths. However, the largest biomass per collection site was gathered from 5 m along Transect 222, which was in the middle of the sampling region.

The low quantities of this plant at the 1 m collection sites was attributed to the scouring effects of wave action.

CHEMICAL---SEDIMENT

Nutrients

Only 9 of 24 Niagara River mouth stations were not rock bottom and therefore evaluation of sediment phosphorus content of this area was only superficial. Generally, Niagara River mouth sediments showed very low P_T values (<100-400 µg P/g). Except for 3 stations, P_{TWS} concentrations were between <0.01 and 1.00 µg P/g. The only sites showing any significant phosphorus content were those farthest away from the mouth of the river ($\sim$2 km).

Of the 45 lake stations established, an average of 34 samples were taken during each of the five cruises. The majority of the stations that did not yield analyzable amounts of sediment were from the 1/2 km contour. Sediment phosphorus analyses of lake samples from Cruise I showed that the P_T areal distribution was greatest for those sediments with concentrations between 800 and 1200 µg P/g (Figure 29). The 100-400 µg P/g band extended to the 4 km contour from the west edge of the study area to the eastern most boundary of the Niagara River plume. Generally, eastward of that point, the 400 µg P/g isopleth was at a distance of approximately 2 km from shore. The 400-800 µg P/g area extended from approximately 4 km to 6.5 km near the Niagara River mouth. From this point eastward it narrowed to a width of approximately 2 km. To a great extent the 800 µg P/g isopleth paralleled the 4 km contour. The 800-1200 µg P/g band generally extended from about the 4 km to the 8 km contour except near the Niagara River mouth and at Stations 215 and 224, where the P_T concentrations were greater than 1200 µg P/g. The overall P_T concentration at the various stations during this cruise was higher than at any of the other cruises.

The P_{TWS} concentration during Cruise I (Figure 29) showed the 1.00 µg P/g isopleth at a distance of approximately 2 km from shore, except at the Niagara River mouth. The 2 µg P/g isopleth parallels the 4 km contour and the 2-3 µg P/g distribution extends to the 8 km contour except at the deep lake stations where the P_{TWS} concentrations are greater than 3 µg P/g.

During Cruise III, the spatial distribution of the 100-400 µg P/g for P_T extended to about the 4 km contour (Figure 30). The 800 µg P/g isopleth generally parallels the 8 km except at the seventh (numbering from west to east) transect where it dipped to a distance approximately 4.5 km from shore. Station 221, a deep lake station (135 m), exhibits a P_T concentration of 2170 µg P/g. The sediment P_{TWS} concentrations show an overall increase since Cruise I (Figure 30). The < 0.01-1.00 µg P/g band has narrowed to from 1 to 1.5 km from shore except at the Niagara and Genesee River mouth areas. The 2 µg P/g isopleth was variable but generally within the 4 km contour. The 2-3 µg P/g band extended to the 8 km contour on the westward edge of the study area. Generally, the P_{TWS} concentrations were greater than 3 µg P/g from approximately 4 km to the 8 km contour from the third to the twelfth transect.

The P_T in the sediment collected from Cruises VI and IX is illustrated in Figures 31 and 32, respectively. The distribution of P_T concentrations was approximately the same as those found during Cruise III. There was, however, a slight decrease in overall P_T at Cruise VI and again at Cruise IX.

The same situation for P_{TWS} was not applicable to the littoral zone of Lake Ontario. The P_{TWS} content during Cruise VI (Figure 31) showed a drastic reduction from Cruise III. At this time approximately 85% of the study area was in the range of <0.01-1.00 µg P/g.

During Cruise IX (November 1972) the overall P_{TWS} concentration was seen to increase. Much of the study area was still in the range of <0.01-1.00 µg P/g (Figure 32). Increases were noted near the Niagara River and again between the fifth and twelfth transects. The 1.00 µg P/g isopleth extends from the 8 km contour to approximately 1.5 km from shore at the eighth transect and slowly returns to the 8 km contour. The same basic pattern was seen for the 2 and the 3 µg P/g isopleths.

Analyses of sediments from Cruise XI show the P_T values (Figure 33) to be quite similar to those found during the same period the year before (Cruise I), except for some higher values at the 8 km contour. The net effect was an increase from Cruise IX. P_{TWS} concentrations during this final cruise (Figure 33) show an areal increase from Cruise IX and also were seen to be approximately the same as for those found during Cruise I.

The Genesee River mouth stations all yielded analyzable amounts of sediment. P_T and P_{TWS} values at these stations were considerably higher than at the Niagara River mouth stations. Except for higher values at the 2 stations at the mouth of the channelized section of the river, the P_T values were comparable to those found at the 4 km contour in lake stations of the nearshore zone. P_{TWS} concentrations were similar to those at the 8 km stations in the nearshore zone. Generally, the P_{TWS} values were between <0.01 and 1.50 µg P/g except during the first cruise when the range was from 0.08 to 4.72 µg P/g. No statistically significant changes in P_T or P_{TWS} concentrations were noted at the Genesee River mouth stations from spring 1972 to spring 1973.

Means and ranges for all sediment nitrogen parameters are shown in Tables 28-31.

The Niagara River mouth and the Genesee River mouth showed no variation with respect to distance from shore or from east to west, for any nitrogen forms measured.

In the nearshore zone, mean nitrate concentrations were generally highest along the 8 km contour. The mean nitrate concentrations at the 8 and 4 km contour showed the same basic west to east fluctuations (Figure 34); however, the magnitude of the nitrate concentration was greater at the 8 km contour. Nitrate concentrations througout the year were significantly higher at the eastern end of the study area.

Station 357, a Genesee River mouth station, had concentrations which were greater by a factor of 10^2 over the other stations sampled. This area of high nitrate content was consistent throughout the year, with a mean of 4.4 and a range of 3.4 to 5.8 mg N/g. It is believed that this area of high concentration was a function of an unknown change in geomorphology.

Ammonia concentrations showed increasing concentration with increasing distance from shore during the majority of the study period with only one exception, Transect 219-221, which showed decreasing values with increasing distance from shore for each cruise. The highest areal concentrations were along the 8 km contour from Station 206 to 215 and along the 4 km contour from Station 211 to 220 (Figure 35).

Generally, it can be stated that the 8 km contour had higher organic-N concentrations than did the 4 km contour, but consistently the observed organic-N concentrations between the 8 and 4 km contour, were seen to be inversely proportional throughout the study area (Figure 36).

Yearly total-N fluctuations followed those of organic-N (Figures 36-37). This phenomenon is obvious, since generally >50% of the total-N concentration was organic in nature.

The Niagara River mouth for purposes of description was divided into a western and eastern zone. The western zone included Stations 363-374 and 376, and the eastern zone included Stations 375 and 377-386. The means and ranges for the carbonate carbon (CC) and the organic carbon (OC) at the collections from the western zone were 1.44% CC, 0.10-6.75 CC and 0.21% OC, 0.03-1.34 OC, respectively. The means and ranges for CC-OC in the eastern zone samples were 0.88% CC, 0.68-1.07% CC and 0.07% OC, 0.05-0.14% OC, respectively. During the IFYGL project 38 samples were analyzed for CC-OC, thirty-three samples from the western zone and five from the eastern zone. Table 32 shows that the western zone sample means and ranges were consistently higher in CC-OC than those from the eastern zone. The maximum CC mean in the western zone was observed during Cruise VI with the minimum occurring during Cruise I. The eastern zone collections had the highest CC mean during Cruise III with lowest means observed during Cruise I. Highest mean OC values in the western zone occurred during Cruise VII with the lowest mean being observed during Cruise VI. With respect to the eastern zone samples, the maximum OC mean was noted during Cruise VII with minimum means observed during Cruise I and III.

The means and ranges for the carbonate carbon (CC) and the organic carbon (OC) for the southwestern nearshore zone samples were 0.63% CC, 0.29-1.14% CC and 0.11% OC, 0.03-0.71% OC at the 1/2 km contour; 1.26% CC, 0.18-2.70% CC and 1.01% OC, 0.09-2.51% OC for the 4 km contour; 0.92% CC, 0.04-2.67% CC and 1.51% OC, 0.38-2.80% OC at the 8 km contour, respectively. Table 33 lists the means and ranges by cruises for each 1/2, 4 and 8 km contour. Carbonate carbon reached a maximum during Cruise VI at the 1/2 km contour, Cruise XI at the 4 km and Cruise I at the 8 km contours. Minimum CC means were observed in the samples during Cruise IX at the 1/2 km contour and Cruise VI at the 4 and 8 km contours. With respect to temperature, the maximum CC means were observed during spring unithermal conditions and minimum CC means during late summer stratified conditions in the 4 and 8 km contour samples. The 1/2 km contour samples were more complex with a fluctuating pattern. The OC reached maximum means during Cruise VI in the 1/2 and 4 km contour collections and Cruise XI in the 8 km contour collections. Minimum OC means were observed in the Cruise I and IX samples from the 1/2 km contour and Cruise I from the 4 and 8 km contour. Generally the OC appeared to increase to a maximum during thermal stratified conditions then decreased to a minimum during unstratified conditions in the samples from the 1/2 and 4 km contours. The OC means appeared to be constant at the 8 km contour collections, with a possible accumulation from spring 1972 to spring 1973. Figure 38 shows the relative CC-OC means from station to station and transect to transect. The 1/2 km contour was sampled at only five stations during IFYGL. The CC was relatively high at Stations 228, 231 and 234 collections and relatively low in those from Stations 240 and 243. Organic carbon was low and made up the smaller percentage of carbon observed in the 1/2 km contour samples. It was noticed that the CC-OC means at the 4 km contour samples displayed a similar gradient. Carbonate carbon means were generally higher than OC means except for the samples at Stations 217 and 220. Maximum CC-OC means were noticed in the collections at Stations 211-223, 229 and 232 at the 4 km contour. Minimum CC-OC means were observed in the collections from the western and eastern sections of the southwestern nearshore study zone at the 4 km contour. For the 8 km contour samples, the OC means were generally higher than the CC means. Carbonate carbon means were highest in the Stations 206 and 209 collections then decreased in an easterly direction and leveled off to a range between 0.50 to 1.00% CC for the remainder of the study zone. Organic carbon means also were highest in the samples from Stations 206 and 209. However, high values were also noticed in samples from Stations 224-236 at the 8 km contour.

The Genesee River samples had a mean and range for CC of 0.75%, 0.05-1.44% CC and for OC of 0.95%, 0.09-4.25%. During the IFYGL project, 58 Genesee River mouth samples were analyzed for CC-OC. Table 34 shows the CC mean was highest in the Cruise I samples and decreased to a relatively constant level for the rest of the field year. Organic carbon fluctuated having a maximum mean during Cruise VI and a minimum mean during Cruise V. Figure 39 shows the OC means to be highest through the central portion of the river mouth with lows extending east and west along the contours. An exception was the collections from Station 361 which had the highest OC mean for the Genesee River mouth stations. It was observed that the far shore contour collections had the highest CC means. Carbonate carbon means were constant ranging from 0.50% to 1.00% CC for the samples from the Genesee River mouth stations. Station 355 samples were an exception having a CC mean below 0.50%.

Toxicants

Average sediment metal concentrations were calculated for each of the five cruises on the Niagara River mouth, the Lake Ontario nearshore, and the Genesee River mouth during which the sediment was sampled. These overall averages as well as the respective range of values are displayed in Table 35.

The five Niagara River mouth cruises yielded a total of only 38 sediment samples of sufficient quantity to enable heavy metal analyses to be carried out. Only five sediments were analyzed for Cruise I and for Cruise III. Cruises IV and VI had ten sediments each, while Cruise VII had eight. Usually, at least two stations from the transect nearest the mouth were sampled consistently, while the remaining samples usually came from stations in the western half of the study area. No values are reported for Cruises I and II for magnesium, iron, and manganese due to their wide variation and suspiciously low nature. Similarly, zinc and nickel values for the same two cruises are believed to be atypical and inconsistent with the other values reported and are thus not included in the table.

Five Lake Ontario nearshore cruises (I, III, VI, IX and XI) yielded sufficient quantity of sediment for analysis to include heavy metal evaluation (primarily from the 8 km and 4 km stations). Generally, samples from only 2 or 3 of the 1/2 km stations per cruise were examined for heavy metals. These collections primarily were from the eastern end of the study area. Iron and nickel values from Cruises I and III were highly questionable, unreasonably low, and inconsistent with the other data for these metals. These along with cadmium values from Cruise I (which were questionably high) were very unreliable and are not included in the table of averages and ranges.

All sediment samples from Cruises I, V, VI, VIII, and IX on the Genesee River mouth were analyzed for heavy metal concentrations. However, due to unreasonably low values and other inconsistencies, magnesium, iron, and manganese values for the first two cruises are not reported. Poor detectability and low reliability eliminated zinc and nickel values (for the same cruises) from discussion.

The average magnesium concentration appeared to double from Niagara River mouth Cruise IV to VI. However, the Cruise VI average seems to be questionably high. In fact, the nearshore Lake Ontario regions of overall high metal concentrations were actually lower in magnesium. Cruise VII showed reduced magnesium concentrations but they were still quite high. The iron values for Cruises VI and VII reflect the statistical elimination of one extremely high concentration per cruise. These were believed to be anomalies. There seemed to be somewhat of a pattern to the distribution of magnesium and iron at the Niagara River mouth. Stations 374 and 377 near the center of the transect nearest the mouth had much higher values than did Station 373 immediately adjacent to them. Stations 369 and 366 (next in line) could not be sampled due to the compact nature of the bottom. This seemed to indicate that there could have been a gradient of compaction as well as changes in sediment type. Current patterns could have had a direct influence although they were not investigated thoroughly enough for any definite correlation to be made.

No apparent areal distribution patterns were found for any other metal concentrations. Fairly constant and relatively low averages were found for most of the metals. Many of the chromium, lead, copper, cadmium and mercury concentrations were below detectability and actual average values should have been lower than actually reported.

Overall averages and ranges for almost all the metal concentrations measured were quite similar from cruise to cruise for the Lake Ontario nearshore region. Various areal distribution patterns were found for different metals. The areas nearest the two river mouths generally contained the lowest metal concentrations. The highest values were usually found in the western half of the study area and particularly at the 8 km stations immediately north and northeast of the Niagara River mouth. The 4 km stations located northeast and east of the mouth also contained high metal concentrations. This pattern is described and quantified in tabular form in a latter section of this report. Generally, this pattern was most apparent for iron, magnesium, lead, mercury, zinc and chromium and to a less extent for nickel, cadmium and copper. The pattern was true to an even lesser degree for manganese. A larger average of manganese concentration was found at the 8 km stations rather than the 4 km stations. This also was apparent for iron. In contrast, the opposite held true for magnesium. Overall concentration averages for each metal at the 8 and 4 km stations are discussed and quantified in tabular form in a latter section of this report. Also tabulated are concentration averages of western and eastern halves of the study area. The western half averaged significantly higher magnesium, iron, zinc, chromium, lead, and mercury concentrations than did the eastern half. Only slight differences between the two sub regions were found for manganese, copper, cadmium, and nickel.

No apparent pattern of metal distribution was found for chromium, nickel, mercury, iron or magnesium for the stations at the Genesee River mouth. Stations 351 and 352 directly at the mouth usually contained higher copper, cadmium, zinc, lead and manganese concentrations in the sediment than did the other collection sites in the river mouth area. Often these higher values also were found directly north of the mouth or at Stations 358 and 362.

All sediment samples were also analyzed for the insecticides lindane, heptachlor, aldrin, heptachlor epoxide, dieldrin, p,p'DDE,o,p'FDE, endrin, o,p'DDF, p,p'FDE, p,p'DDF, chlordane and toxaphene as well as PCB's. All sediments from the southwestern nearshore zone of Lake Ontario were below detectability for both pesticides and PCB's. The limits of detectability are listed in Table 36.

Quality Indicators

All sediments collected with Ponar Dredges were subjected to quantitative and qualitative analysis for solids content. All of the generated data were subjected to Chi-Square Analysis and Analysis of Variance. The results of these statistical manipulations showed no significant difference in the data, either within or between cruises, from the Niagara River mouth stations, the nearshore stations or the Genesee River mouth stations. This being the case, average percent dry weight, fixed weight and volatile weight were calculated. The data from Niagara River mouth stations exhibited a high percent dry weight. These data ranged from 76.5% to 88.3%, with an average of 81.9%, based on 13 of 24 stations that continually yielded analyzable amounts of sediment. The percent fixed weights, an indicator of total inorganic content of the sediment, also were higher in this area. The range was from 91.2% to 98.1% with a mean of 95.5%. The percent volatile solids, an indicator of total organic content of the sediment, were low. These data varied between 1.9% and 8.8% with an average of 4.5%. No spatial or temporal variations in percent dry weights, fixed weights or volatile weights were seen in the Niagara River mouth area.

At the 45 nearshore stations, of which 35 yielded sufficient quantities of sediment that could be analyzed, a definite statistically significant decrease was seen with distance from shore for the percent dry weight and percent fixed weight data. The mean percent dry weights for the 1/2, 4 and 8 km contours were 74.3%, 61.5% and 47.7%, respectively. The mean percent fixed weights for the 1/2, 4 and 8 km contours were 98.1%, 93.8% and 92.2%, respectively. Percent volatile solids, however, exhibited the opposite trend; a statistically significant increase with distance from shore. It was also noted that percent dry weights and percent volatile solids content of the sediments in the western portion of the study area (from Station 201 to 224) were significantly higher than in the eastern portion of the study area (from Station 225 to 245). Percent fixed weights were, however, consistently lower in the western portion of the study area.

At the Genesee River mouth stations, all twelve sites during each cruise yielded sufficient amounts of sediment for solids analysis. These data exhibited an average percent dry weight comparable to those seen at the 4 km contour of the nearshore stations. Also noteworthy was that percent dry weights were consistently lower than those for collection sites at the Niagara River mouth. Both the percent fixed weights and percent volatile solids data were also comparable to the values seen at the 4 km contour of the nearshore stations. However, these data were seen to be approximately equal to the results exhibited from sites at the Niagara River mouth. The percent dry weight data varied between 62.8% and 78.6% with a mean of 68.8%. The percent fixed weight data showed a range of 43.2% to 97.6% with an average of 95.5%, while percent volatile solids data had a mean of 4.5% in a range of 2.4% to 6.8%.

CHEMICAL---WATER

Nutrients

All phosphorus data was statistically treated in the following manner. Lake Ontario, Niagara River, and Genesee River Cruises I and II were grouped and labelled as the Unithermal period of 1972. Lake Ontario and Genesee River Cruises III-VII and Niagara River Cruises III-V were grouped as the Thermal Stratification period. Note that this labelling does not suggest that the Niagara and Genesee River plumes stratify, only that the time periods of these cruises approximately correspond to the period of thermal stratification of Lake Ontario. Genesee River Cruises VIII and IX, Lake Ontario Cruises VIII-XIII and Niagara River Cruises VI and VII were grouped as the Unithermal period of 1973. Phosphorus data for each station was averaged from the total number of cruises for each of the three time periods. Lake Ontario data was divided into stations above and below a depth of twenty meters. All concentrations reported in tables and graphs are mean average concentrations and ranges are average values.

During the three time periods studied, the total phosphorus (P_T) concentration in the Niagara River mouth showed an increase with each time period (Table 37). Values for the stratification time period were very high due to excessively high reported P_T concentrations during Cruise III.

During the unithermal period of 1972, an increase of P_T concentration was observed with increased distance from the Niagara River mouth (Figure 40). This trend was reversed during the stratified and unithermal conditions of 1973. The P_T concentration decreased with increased distance from the Niagara River mouth as seen in Figures 41 and 42.

The P_T concentration for Lake Ontario during the unithermal conditions of 1972 and 1973 were homogeneous for each throughout the study area. During both time periods the mean averages and ranges were uniform for stations above and below a depth of twenty meters. The stratification period shows the greatest change in mean average P_T concentration between stations above and below a twenty meter depth (Table 37). A general trend noted was the decrease of P_T concentration as the sampling distance from the shore increased for stations above 20 meters (Figures 43-45). The stations below 20 meters showed isolated pockets of high P_T concentrations primarily in the western section of the study area. The mean average P_T concentrations for the Genesee River were similar during the unithermal periods of 1972 and 1973 (Table 37). An unusually high average P_T concentration was reported for the stratification time period. Again, the trend of the decreasing P_T concentration with increasing distance from the Genesee River mouth was observed during the stratified and unithermal condition of 1973 (Figures 41-42).

During the unithermal conditions of 1972, the dissolved phosphorus (P_D) concentration in the Niagara River averaged 0.11 mg P/l. The average P_D concentration decreased during stratified conditions and resumed a similar level to unithermal 1972 during unithermal 1973 (Table 38). During each of the three time periods, the average P_D concentrations remained relatively uniform throughout the plume of the Niagara River mouth (Figures 46-48).

Lake Ontario showed a comparable trend for the three time periods studied. The P_D average was the lowest during the thermally stratified time period and was the same for both unithermal periods (Table 38).

In the unithermal period of 1972, the average P_D concentration above 20 meters showed a decrease with increased distance from the shore. During the stratified and unithermal conditions of 1973, P_D concentration for the same depths was almost uniform throughout the study area with a few high concentrations in isolated packets (Figures 49-51).

Below the 20 meter depth, the mean average P_D concentration showed a direct relationship with increased distance from the shore during the stratified and unithermal conditions of 1973 (Figures 49-51).

No data was available for the P_D concentrations during the unithermal period of 1972 for the Genesee River mouth stations. The P_D average concentration during the stratified time period was less than one half of the cencentration during the unithermal conditions of 1973 (Table 38). The P_D concentration showed the same trend observed in the P_T concnetration. The P_D concentration was inversely related to the distance from the shore in the Genesee River mouth (Figures 46-48).

The ortho phosphorus concentration (P_O) did not vary significantly over the first two time periods (Table 39). P_O average mean concentrations were uniform throughout the Niagara River, Lake Ontario and Genesee River during unithermal and stratified periods (Figures 52-55). No data was available for P_O concentration during the unithermal conditions of 1973.

During the entire IFYGL program, only seven stations were analyzed for hydrolyzable phosphorus. Therefore, no meaningful statements concerning this parameter will be offered.

Means and ranges of various forms of nitrogen concentrations are shown in Tables 40-45. This data represents all of the STORET retrievable material as inputed by the U.S.EPA Rochester Field Office.

At the Niagara River mouth during Cruises I, II, IV and VII, the mean surface nitrate concentrations were higher than that of the mid or bottom depth. During Cruises III, V, and VI, the mid-depth exhibited the highest mean concentration. No other areal distribution was ascertainable. (Table 40)

The nearshore stations showed a decrease in nitrate concentration as stratification increased. Except for Cruise I, the mean surface concentration was always less than the mid or bottom mean concentration. However, the magnitude of the increase in nitrate concentration was inconsistent from station to station. (Table 41)

In the Genesee River mouth, the surface nitrate concentration of Station 351 was always the upper limit of the range. (Table 42)

Ammonia concentrations in the Niagara River mouth showed no consistent areal distributions. (Table 43)

Lake Ontario ammonia concentration increased from early spring to late summer. No variations with depth or distance from shore were observed. (Table 44)

The ammonia concentrations at the Genesee River mouth showed a decrease from the surface to the bottom depths. Stations farthest from the mouth of the river exhibited lower concentrations than were found at stations near the mouth. (Table 45)

No organic-nitrogen or total nitrogen data were retrievable from STORET.

Results from dissolved silica data were grouped by three time periods. Silica concentrations at the Niagara River mouth stations averaged 0.123±0.02 mg/l during the spring 1972 unithermal conditions but increased significantly during the stratification period to 0.215±0.02 mg/l. Little or no variation, either areal or with depth, was noticed in the silica results at the Niagara River. No data was available from Rochester EPA after Cruise VIII (10/6/72).

At the lake stations during the first period, April to June 1972, the surface waters averaged 0.45 mg/l while the bottom waters had a mean of 0.64 mg/l. The bottom waters also exhibited an increasing silica content with distance from shore. It is also noteworthy that the silica in the bottom waters in the western end of the study areas near the Niagara River (although not evidenced by the Niagara River mouth data) were significantly higher than at the eastern end of the study area.

During the second time period, 2 June to 5 October 1972, when the lake was thermally stratified, the dissolved silica was again higher in the bottom or hypolimnetic waters. The epilimnion average was 0.39 mg/l while in the hypolimnion, the concentration average was 0.49 mg/l. As during the first period, the hypolimnetic silica increased with distance from shore.

STORET retrievals (RET and INVENT) for the period 6 October 1972 to 1 June 1973 yielded no silica data at the Genesee River mouth stations. During the first and second sampling periods, the silica data averaged 0.20±.09 and 0.21±.08 mg/l, respectively. Again, no data was available after Cruise VIII. These average concentrations were comparable to those found at the Niagara River and were generally lower than those found at the lake stations. Also noteworthy at the Niagara River was the fact that the silica content increased from the first to second sampling period, while in the lake it decreased. At the mouth of the Genesee River, the concentrations remained relatively constant.

Toxicants

Cadmium and lead concentrations were measured on samples only from Lake Ontario Cruise I. Cadmium concentrations averaged 6 µg/l in both the surface and bottom samples. The ranges were 2-9 µg/l and 3-8 µg/l, respectively. Lead concentrations averaged 21 µg/l in a range of 1-58 µg/l for the surface samples and 23 µg/l in a range of 3-59 µg/l for the bottom samples. A slight distribution pattern was observed and is discussed in a latter section of this report.

Other metal concentrations were measured on one Niagara River mouth cruise, two Genesee River mouth cruises, and eight Lake Ontario nearshore cruises. Table 46 describes the number of samples measured for both the surface (S) and bottom (B) depths. Since not all of the samples for each cruise were measured, the percentages of the total number of stations are listed to indicate how representative the averages are. The station numbers and a brief general description of the area analyzed are also shown.

Table 47 lists the averages and ranges for manganese, nickel, zinc and copper concentrations in the surface and bottom samples for each cruise. Nickel was not measured on samples from Lake Ontario nearshore Cruise I. Zinc was not measured on samples from Lake Ontario nearshore Cruise VI.

No patterns of distribution were found in the Niagara River mouth for any of the metals. Nickel concentrations were the most uniform and zinc concentrations were the most varied (largest range).

Lake Ontario nearshore Cruises I, VI, VIII and X are difficult to discuss due to their lack of sufficient measurements to characterize the whole nearshore zone. The averages and ranges are reported because they are similar to those for the more complete cruises. Manganese concentrations seemed to decrease with distance from shore for Cruises IX, X, XI and XII. Nickel concentrations, except for Cruise VI, were fairly uniform. Average zinc concentrations varied considerably from cruise to cruise. However, no apparent trends were deducible. Comparisons of iron and manganese concentrations, copper and zinc concentrations, and others are discussed in a latter section of this report.

The average metal concentrations for the Genesee River mouth cruises and the Niagara River mouth cruises seem to agree with the data found in the respective areas of the corresponding Lake Ontario nearshore cruises.

Quality Indicators

Total organic carbon (TOC) data for the Niagara River mouth stations were retrieved from the STORET system for Cruises I, II, VI and VII. The total means and ranges of the cruises were respectively at the surface 3.0 mg/l TOC, 1.0-6.7 mg/l TOC and at the bottom 3.0 mg/l TOC, 1.0-7.6 mg/l TOC. Table 48 shows that maximum TOC means were observed during Cruise I with minimum TOC means observed during Cruise II. Figure 56 shows the surface waters at the central stations of each contour (except the close shore contour) had the highest TOC means. Other high values were observed in the data from the far western and eastern stations of each contour. The bottom waters had the highest TOC means in the western portion of each contour (except Station 363). The lowest TOC means were noticed in the samples from the central and eastern section of each contour.

Total organic carbon data for the southwestern, nearshore zone of Lake Ontario was retrieved from the STORET system for Cruises I, VII, IX, XI, XII and XIII. Total organic carbon values were obtained on only one cruise (VII) during which stratification was observed. All other TOC values were obtained during unstratified or thermal bar conditions. The total means and ranges of the collections of the retrieved data from the cruises at the surface were 3.2 mg/l TOC, 1.0-8.0 mg/l TOC at the 1/2 km contour; 3.1 mg/l TOC, 1.2-8.2 mg/l TOC at the 4 km contour; 2.9 mg/l TOC, 1.0-5.8 mg/l TOC at the 8 km contour. The samples from the bottom had means and ranges of 3.0 mg/l TOC, 1.2-5.8 mg/l TOC at the 1/2 km contour; 3.1 mg/l TOC, 0.9-9.1 mg/l TOC at the 4 km contour; 2.8 mg/l TOC, 0.7-6.4 mg/l

TOC at the 8 km contour. Table 49 shows that the highest TOC means were obtained during the spring cruises of 1972 and 1973 (Cruise I and XI), whereas the lowest TOC means were noticed during Cruise VII. Figure 57 shows a fluctuating pattern in the collections from the 1/2, 4 and 8 km contours for both the surface and bottom waters. A distinct trend is noticed at Stations 219-230. The surface water samples showed consistently higher TOC means than the bottom waters. Total organic carbon means were high in the surface water collections at Stations 201, 215, 217, 226, 228, 229 and 230, and low at the samples from Stations 221 and 239. High TOC means in the bottom water collections from Stations 202, 206 and 237 and low TOC means in the samples from Stations 221 and 238 were noticed.

Total organic carbon (TOC) for the Genesee River was retrieved from the STORET system for only Cruises V and IX. The mean and range for the Cruise V collections were 3.3 mg/l TOC, 2.4-5.2 mg/l TOC (surface) and 2.2 mg/l TOC, 1.6-2.6 mg/l TOC (bottom). Cruise IX samples were 3.5 mg/l TOC, 2.6-4.8 mg/l TOC (surface) and 3.1 mg/l TOC, 2.3-4.0 mg/l TOC (bottom).

Tables 50 and 51 describe the number of samples which were measured for calcium, magnesium, sodium, potassium and iron at both the surface (S) and bottom (B) depths. Since not all of the samples for each cruise were analyzed for the above mentioned parameters, the percentages of the analyses completed are listed. This information is indicative of the representative nature of the results. The station numbers and a brief general description of the area analyzed are also shown.

Table 52 lists the averages and ranges for calcium, magnesium, sodium, potassium and iron concentrations in the surface and bottom samples for each cruise.

The cation concentrations were fairly constant throughout the Niagara River mouth Cruises II, III and VI. Cruise VII in the spring of 1973 showed higher averages for calcium, magnesium, sodium and potassium. During Cruise III, the higher concentrations of these four cations were found near the Canadian shore. This was not found during the other cruises. Iron concentrations were measured on only one cruise and a large range with a variety of values was found.

Lake Ontario nearshore Cruises I and II yielded high average concentrations and wide ranges for calcium, magnesium, sodium and potassium. Calcium concentrations seemed to follow a seasonal change. Cruise IV values decreased from Cruise II. The values for the surface samples increased through Cruises VI, VII, and VIII. The values for the bottom samples were higher than the surface ones. These remained fairly constant through Cruises VI, VII, and VIII. The vertical differentiation disappeared by Cruise IX. Calcium concentrations were lower in the spring of 1973 (Cruise XI) and evenly distributed with depth. Magnesium, sodium and potassium seemed to show no significant variation with depth or with time. More definitive discussion can be found in a latter section of this report.

The Genesee River mouth Cruises VIII and IX indicated higher values of calcium, magnesium, sodium, and potassium in the stations nearest the river (Stations 351 and 352). The highest averages for the whole study were usually found in this area.

The only apparent significant trend for iron concentration was that the values decreased on the average with increasing distance from shore. Water samples collected at the Niagara River mouth stations and analyzed for sulfate content showed no significant change from the unithermal spring 1972 conditions to the stratified conditions of that summer. The average sulfate concentration during these two periods were 45.0±12.0 and 33.2±7.7 mg/l, respectively. No data from after 5 October 1972 was retrievable from STORET. No significant variation in distribution or with depth was noticed.

Sulfate analyses on approximately 60% of the water samples from the 45 lake stations during Cruises I through VIII were retrievable from STORET. The average surface and bottom water sulfate concentrations during the first period (1 April - 1 June 1972) were 51.6 and 40.6 mg/l, respectively. The statistical significance of these differences between the results is weak due to the wide range of sulfate values found. No significant areal variations were found. During thermal stratification, there was no significant differences or areal variations in the sulfate results. However, there was a significant increase from the first to the second period. During this second period (2 June to 5 October 1972), the average sulfate concentration was 89.5 mg/l, almost a two-fold increase from the unithermal condition in the spring of 1972.

The average sulfate concentrations of the samples from the Genesee River mouth stations during the spring of 1972 and the stratification period were 38.3±3.6 and 54.0±7.6 mg/l. The data from these two periods did yield an increase believed to be statistically significant, as was the increase in the results from the lake stations. Again, no areal or depth variation was noted in sulfate content. No data for sulfate analysis of samples collected after Cruise VIII was available.

Samples from the Niagara River mouth stations analyzed for fluoride content showed little variation over the time period 1 April - 5 October 1972. No other data was available. The averages and deviation during both periods (1 April - 1 June and 2 June - 5 October 1972) were 0.130±.030 mg/l. No areal depth variation was found.

Aqueous fluoride concentration at the lake stations were relatively constant for the data retrievable from STORET (Cruise I through VIII). During the first period (1 April - 1 June 1972), the surface fluoride concentration average was 0.120±0.013 mg/l, while the bottom waters averaged significantly lower, 0.076± 0.012 mg/l. No statistically significant areal variations were seen in either the surface or the bottom waters during this period. During the period of thermal stratification (2 June - 5 October 1972), the epilimnion and hypolimnion water averages for fluoride ions were 0.122 and 0.125 mg/l, respectively. Again, no areal variations were found in the F^- data.

In the samples from the Genesee River mouth stations, the results from fluoride analyses were quite similar to those found at the Niagara River and lake stations; the average concentration during the first and second sampling periods were 0.107 and 0.110 mg/l, respectively. No variation with time, depth, or areal distribution was ascertainable from the available data.

Of the samples delivered to the Rochester Field Office of the EPA, chloride measurements were completed on the greatest number, approximately 70%.

The chloride concentrations found at the Niagara River mouth stations were relatively constant throughout the year. During the period 1 April through 1 June 1972, the chloride average was 24.5±2.1 mg/l, while during the stratified period, 2 June through 5 October, the average was 25.2±1.3 mg/l and from 6 October 1972 through 1 June 1973, the average was 25.6±1.0 mg/l. No areal or depth variation was ascertainable at the lake stations.

During the unithermal condition of Spring 1972, the chloride concentrations were relatively constant regardless of depth; the lake stations yielded an average of 27.1 1.1 mg/l with a range of 23.6-29.0 mg/l. During this time period, there was an indication of increasing chloride concentration with distance from shore in both the surface and bottom waters. During the stratified period, the chloride concentration was 26.5±2.1 with a range of 16.4-32.8 mg/l. Again, during this period there was evidence of increasing concentration with distance from shore.

From fall turnover 1972 to spring of 1973, the data again showed an increase in chloride concentration with distance from shore. It also was apparent that there was no variation with depth. The surface and bottom water chloride concentration averages were 27.2±1.2 and 27.3±1.1 mg/l, respectively. At the Genesee River mouth stations, as well as the Niagara River and the lake stations, no variation in chloride content was seen with time, depth or areal distribution. The chloride concentrations during the three time periods were 29.2±1.2, 27.9±1.2 and 28.2±3.0 mg/l, respectively.

The following results of chlorophyll-a (chl-a) deal with values obtained at a one-meter depth unless otherwise indicated. All chl-a values have been corrected for pheopigments and are expressed as micrograms chl-a per liter (μg/l).

The chl-a data from the Niagara River mouth stations were the results of only four cruises (IV, V, VI and VII). The samples from Niagara River Cruise IV had a mean chl-a concentration of 4.1 and a range of 2.0-6.8 μg/l. The collections from the second cruise exhibited a mean of 5.8 and a range of 2.1 to 9.7 μg/l. The third cruise, Niagara River VI, yielded samples with a mean of 2.7 with a condensed range of 1.2 to 4.4 μg/l. The samples from the final cruise, Cruise VII, had a mean of 4.9 with a range extending from 2.5 to 11.7 μg/l.

In general, the values of chl-a at depths other than one-meter were similar to the one-meter values. In bisecting the Niagara River mouth stations into eastern and western sectors, it was found that there were no significant differences in the values between each sector.

Samples from a total of 13 cruises were prepared for chl-a analyses on the nearshore lake stations. The following does not include the means of the samples from all the cruises since this information is presented in Table 53. Contour means from each cruise are listed in Figure 58. Only the data from those cruises where relatively complete samplings were taken, were included. As mentioned previously, all mean values were from a one-meter depth unless otherwise noted.

Lake Ontario Cruise I samples had a mean value of 3.9 (Table 53) with a range consistent with those found during other cruises. Through examination of Figure 58, a decrease in chl-a concentration with increased distance from shore is readily observed. The following means and contour graphs do not include values from Stations 240 and 243 during Cruise III since these values, 78 and 55 μg/l respectively, were found to distort the general pattern. Other chl-a values deleted include Station 243 (Cruise IV) and Station 244 (Cruise II), which had values of 52 and 29 μg/l, respectively. During Cruise III there also was a decrease in chl-a values with increased distance from shore. The data in Figure 58 indicates that this was the general rule during the majority of the cruises. Cruises VI, VII and VIII were the exceptions since chl-a development between each contour during these cruises was essentially uniform. Cruise X collections have been omitted from this description since the data generated was insufficient to calculate reliable means.

Dividing the stations into western, central and eastern sectors did not yield significant differences in the chl-a. However, as described below, there were differences when the area was divided in half.

The following discussion of the vertical profile will be limited to the results obtained from samples taken at Stations 203, 224, 233 and 245 which are all 8 km from shore. Stations 224 and 233 will be discussed in greater detail since they are centrally located in the study area and were believed to be representative of the situation in the nearshore zone. Stations 203 and 245 were located in the vicinity of the Niagara and Genesee Rivers, respectively. Figure 59 illustrates the vertical distribution of chl-a at the selected stations for the spring of 1972 and 1973. Generally, a uniform distribution of chl-a throughout the water column was observed. Figure 60 illustrates the chl-a concentrations at these same stations during stratification and fall overturn. During stratification, a general decrease in chl-a with increasing depth was observed. The exception to this trend was the lower chl-a concentration at the one-meter depth as compared to the five-meter depth. The chl-a distribution for the fall overturn period was similar to the spring distribution with fairly uniform chl-a values throughout the water column. A more detailed representation of chl-a distribution at Stations 224 and 233 (Figure 61) illustrated the same pattern. The graph illustrates fairly uniform chl-a development in the water column during the spring periods at both stations. During stratification, a general decrease in chl-a with increasing depth was observed at each station.

It also was noted that the movement of the spring thermal bar exerted an influence on chl-a development in the nearshore zone.

The chl-a data from the Genesee River mouth stations were the result of collections from only one cruise, Genesee River Cruise XII.

The mean chl-a concentration for all stations at a depth of one-meter was 12.4 μg/l. Dividing the sampling stations into a western and eastern sector, a difference was noted. Comparing the results from the one-meter depth collections, the western sector had a chl-a mean of 14.8 μg/l while the eastern sector collections had a lower mean of 10.4 μg/l. When the means of chl-a, regardless of depth, were compared, the western sector samples were also higher than those from the eastern sector.

SECTION V
DISCUSSION

PHYSICAL

The GLL's physical observations made in 1973 and 1974 did not differ appreciably from those noted previously by others (Canada Centre for Inland Waters 1969a, 1969b, 1969c, 1969d, 1969e, 1969f; Great Lakes Institute 1964; Hackey 1952; Murthy 1969; Rodgers 1963, 1966; Rodgers and Sato 1970; Weiler and Murty 1971; Yu and Brutsaert 1968) during similar limnological seasons. However, since the sampling intensity, both in terms of geographic spacing of stations and time intervals between data collections, within the study zone by these previous reasearchers did not approach that of the GLL, it was not statistically valid to contrast their findings with those reported in this study.

From the Great Lakes Lab's results, it appeared that the seasonal vertical and horizontal temperature patterns observed in the study area were similar to those noted in other parts of Lake Ontario (Rodgers and Anderson 1963). The similarities in the results, particularly among those from transects east of the Niagara River to those west of the Genesee River, were noteworthy. This was probably due in part to a low intensity of human shoreline development, a lack of major tributaries and fairly uniform depth and geology of the basin.

The major "external" factor that influenced year-round physical conditions appeared to be the Niagara River. However, the impacts of this tributary were largely restricted to the western end of the study region. On the other hand, the major impact of the Genesee was restricted to early spring when maximum discharges occurred. The impacts of such events appeared to be confined to the Rochester embayment.

Tropical Storm Agnes, which markedly affected the Genesee River with little effect on the Niagara, did not appear to have any major influence on the physical and other results amassed by the GLL during 1972-73.

Phytoplankton productivity influenced both dissolved oxygen and light measurements. Outside the Niagara and Genesee River plumes, highest oxygen and lowest light transmission values were noted when and where phytoplankton concentrations were observed to be highest. The quantities and seasonal changes in the dissolved oxygen and light measurements noted at those stations not in the Niagara and Genesee River plumes were typical of those reported for dimictic oligotrophic and mesotrophic lakes.

BIOLOGICAL

Phytoplankton

The following description compares the Niagara River mouth, the Genesee River mouth and the most closely coinciding nearshore Lake Ontario stations.

During spring 1972, the phytoplankton biomass of the Niagara River was generally lower than that of the Genesee River or Lake Ontario. This compares the mid-May cruise of Lake Ontario and May-June cruises of the river mouths. The majority of the biomass in the Niagara River was *Cryptomonas erosa* Ehrenberg while *Melosira binderana* Kuetzing comprised the majority of biomass in both the Genesee River and Lake Ontario. The biomass of *M. binderana* was as high as 2135 mg/m^3 and 4569 cells/ml at Station 362 in the 1 meter collections. The highest values reached by this species at the Niagara River mouth at this time was 225 cells/ml with a biomass of 2619 mg/m^3 in the 1 meter collection at Station 386.

The species assemblage at this time at the Genesee River mouth closely resembled those species found in the lake. The Niagara River mouth on the other hand did not display as many species and those that were present were fewer in number. The turbulence of the Niagara River may have caused the biomass and number of species to appear lower, since the cells would not be in the photic zone for a favorable period of time.

During this spring period, as was noted and pointed out from the water chemistry investigations of lake samples, a low Si content existed at the mouths of the Genesee and Niagara Rivers. Phytoplankton biomass at the nearshore stations in the vicinity of the Niagara River mouth was low while that at the mouth of the Genesee was much higher. Looking at these two factors of Si content and biomass and knowing that most of the phytoplankton biomass was diatoms, a relationship between diatoms and Si concentrations is possible at this time. The low Si content at the mouth of the Niagara River may account for the low phytoplankton populations (composed primarily of diatoms) encountered there. On the other hand, the high concentration of phytoplankton which was utilizing Si, may account for the low values of Si there.

The mid-June cruises of the river mouths were not comparable to the lake because of the omission of lake phytoplankton sampling during the month. The mean biomass was again lower at the Niagara River mouth than the Genesee. As in the previous river cruise, *Melosira binderana* was again dominant at the Genesee River mouth and *Cryptomonas erosa* at the Niagara River mouth.

The late August river mouth cruises showed the Niagara River mouth to have a much higher mean biomass than the Genesee. This was due to the contribution of *Staurastrum paradoxum* Meyen and *Ceratium hirundinella* O. F. Müller which were not seen in the Genesee River mouth. Both of these species are large in cell volume; *C. hirundinella*, the largest measured and *S. paradoxum*, the second largest. The large individual cell volumes account for the large overall biomass. These species were present in Lake Ontario during the first half of September when the biomass values were somewhat higher but similar to those observed at the Niagara River mouth in August. These species were not present in the Genesee River mouth collections. This would indicate the introduction of the species into the lake via the Niagara River. The Genesee River mouth also contained amounts of *Peridinium* sp. as mentioned before, as well as the small (<10 u) flagellates, both of which were found in high numbers during the September cruise of Lake Ontario. The flagellates appeared in the Genesee River mouth in numbers as high as 467/ml with a biomass of 11.4 mg/m^3 (Station 359 - 5 meter collection) and in lower numbers in the Niagara River mouth. The conditions found in the Genesee River probably were favorable for the growth of these small flagellates.

The biomass values for the Genesee River mouth of late November (Cruise VIII) approximated the quantities observed a week previously in Lake Ontario. The biomass of the Niagara River, however, was fairly high (855-2,735 mg/m^3) as opposed to the Genesee (58-768 mg/m^3). The Genesee's major species was *Cryptomonas erosa* followed in number by *Tabellaria fenestrata* Lyngbye and other diatoms which were few in number. The Niagara River mouth had only a few species at this time; however, the large diatom *Stephanodiscus Niagarae* Ehrenberg (23,000 u^3) contributed largely to biomass. This species was also present in Lake Ontario during November in small numbers (usually less than 4 cells/ml). In December, *S. Niagarae* appeared in larger numbers (14-24/ml) in the 5 meter collections from Stations 204, 208, and 210. These stations surround and are to the east of the Niagara River mouth. This indicates that the presence of *S. Niagarae* in the lake may have been due to the flow of the Niagara River. Samples were not taken beyond Station 210 in December of 1972 due to weather conditions. Therefore, it is not known if this species was present in the remainder of the sampling area.

What are believed to be two separate species of *Peridinium* appeared, as mentioned before, at separate times during the year. The first, *Peridinium aciculiferum* (Lemm.) Lindem appeared mainly in May. It was especially numerous around Stations 213, 219 and 223 reaching numbers as high as 361 cells/ml or 80% of the biomass. The average cell volume (7,674 µ^3) and size (35.6 x 28.7 µ) coupled with their abundance, contributed significant amounts of biomass to the total. The second, *Peridinium* sp. appeared in September and October. This species was larger (41.3 x 34.3 μ) with a volume of 12,737.4 μ^3. During September (Cruise VI), *Peridinium* sp. was found in most of the samples in numbers up to 80 cells/ml. However, it reached a population of 154 cells/ml and 130 cells/ml at Stations 202 and 231. At both these stations, *Peridinium* sp. contributed over 50% of the biomass. Again at Station 231, in October, this species was found to comprise 39% of the biomass when it reached 212 cells/ml.

Peridinium aciculiferum dominated to a large extent in the spring of 1972, accounting for 13 to 27% of the total biomass. In spring 1973, however, this genus was seldom found in as high a concentration.

In the spring of 1973, the Genesee River mouth was the only area in which *Melosira binderana* became dominant in cell number and volume. The lake cruise, following one week later, showed only a minor appearance of this species.

The second lake cruise of 1973 was dominated with populations of *Melosira islandica* ssp. *helvetica* O. Müller, *Asterionella formosa* Hassall, and *Stephanodiscus tenuis* Hustedt. Collections from the third cruise showed that the dominant species had become *Cryptomonas erosa, Rhodomonas minuta* Skuja and M. *islandica*. It is interesting to note that samples taken at the Niagara River mouth during the interim of these two lake cruises also showed dominant populations of these three species.

It would seem that the influence of the Niagara River flow on the southern shore of Lake Ontario was more clearly evident in spring 1973 than in spring 1972. Reasons for this may be clarified by additional data collected from this region at corresponding dates for both lake and river mouth.

It is implied from the above comparisons of April-May 1972 and April-May 1973 that drastic changes can occur from one year to the next in the same body of water. This points out the fact that multiple year sampling must be conducted to accurately define a body of water. As the data for the spring of 1972 and 1973 are more closely compared, the differences in the two may better define the lake than each alone.

In September an unusual species of *Staurastrum* was observed in small numbers (1-10 cells/ml) in about 40% of the samples. The highest numbers were found in the 1 meter samples from Station 239. The volume of the cell was 2,223 μ^3 and never constituted a large percent of the total biomass; however, this species occurred periodically throughout the cruise and remains unidentified.

Another point that should be noted is the difference in species composition between the spring samples of 1972 and those of 1973. Species of *Melosira* have been correlated with trophic conditions by various workers (Holland 1968; Lund 1962; Rawsen 1956). The presence of *M. binderana* as a dominant in the inshore waters of spring 1972 could have been indicative of eutrophic conditions (Holland 1968, 1969; Munawar and Nauwerck 1971) especially since it has become one of the predominant diatom species in western Lake Erie in the past 30 years (Hohn 1968). *M. islandica* ssp. *helvetica*, however, was found in spring 1973, not *M. binderana*. Nalewajko (1966) found this species predominantly in the central area of Lake Ontario, which is regarded as oligotrophic. In Lake Ontario for the spring of 1970, Munawar and Nauwerck (1971) also found *M. binderana* in high numbers inshore as we did in 1972. It is possible that this condition does not occur every year but its occurrence is increasing as eutrophication continues.

Zooplankton

In general the distribution of the major zooplankters in the nearshore waters of southwestern Lake Ontario followed the same seasonal patterns as others have found recently in Lake Ontario (Patalas 1969; Wilson and Roff 1973; Watson and Carpenter 1974), nearshore southeastern Lake Michigan (Roth and Stewart 1973), and to a lesser extent the Cleveland Harbor area of Lake Erie (Rolan et al. 1973; Czaika unpublished data). *Bosmina longirostris* was present at very low levels in the spring. Watson and Carpenter (1974) reported a major peak in July and August and a somewhat smaller pulse in October. Patalas (1969) observed the *B. longirostris* peak in July in eastern Lake Ontario and in August in the western part of the lake. Roth and Stewart (1973) likewise encountered a summer pulse. Wilson and Roff (1973) found the bosminid maximum in September; the bosminids with mucro pulse was also in September during this study. Patalas (1969) and Roth and Stewart (1973) reported the maximum abundance of *Eubosmina coregoni* in October whereas for this study and in 1970 (Watson and Carpenter 1974) in addition to a major peak in the fall, there was a minor peak in late spring-early summer. There is agreement that the *Daphnia* species and *Ceriodaphnia lacustris* were absent in the spring and peaked in late summer and early fall. The major cladoceran species, thus are summer and fall forms. There is a tendency observed in southwestern Lake Ontario, in Lake Ontario as a whole (Watson and Carpenter 1974), and in southeastern Lake Michigan (Roth and Stewart 1973) for *B. longirostris* to be succeeded by less abundant populations of *Daphnia* spp. and for these in turn to be succeeded by a still smaller population of *E. coregoni*. In these same three areas, immature cyclopoid copepodids were present in low to moderate levels in April and May. Beyond this spring low, there is little agreement among the three studies regarding immature cyclopoids. *Cyclops bicuspidatus thomasi* generally peaked from August through October, but was present in moderate concentrations throughout the year. *Tropocyclops prasinus mexicanus* occurred in low numbers in winter and spring and reached its maximum in the fall.

A comparison of the densities of dominant species in nearshore waters of southwestern Lake Ontario from mid-April through mid-December 1972 and in Lake Ontario as a whole from January through mid-December 1970 (Watson and Carpenter 1974) reveals that the zooplankton of the smaller area was generally representative of the whole lake two years earlier. Greater abundances of the summer warm water Cladocera, bosminids with mucro, *C. lacustris* and *Daphnia* spp., were recorded in this study, which is to be expected considering this study was largely limited to the apparent preferred habitat of these cladocerans. Further, this study included extra months when these cladocerans are virtually absent. Averages of the Watson and Carpenter (1974) data for the whole lake reflect greater abundances of copepods and *E. coregoni* than occurred in the nearshore waters. This is not surprising. The total zooplankton, excluding nauplii which Watson and Carpenter (1974) did not enumerate, for the two areas was about the same (15,631/m^3 for all of Lake Ontario; 16,830/m^3 for southwestern Lake Ontario in 1972).

There is much less agreement between the April-through-December 1972 segment of this study and the June-through-October 1967 study of Patalas (1969) for the whole lake. Generally, Patalas (1969) encountered many more organisms/cm^2 than were found in this study. Particularly striking is the great difference in the abundance of *C. bicuspidatus thomasi*. Patalas (1969) reported 153/cm^2 accounting for 46% of his total zooplankton. With the data for this study calculated in similar fashion (to #/cm^2 and with proportionate numbers of nauplii and immature cyclopoid copepodids added to the number of adults), there were 33/cm^2 for 30% of the total zooplankton. As Watson and Carpenter (1974) also found, the situation is reversed for *T. prasinus mexicanus*. Patalas (1969) found 36/cm^2 for 10.9% of the total, whereas in this study there were 30/cm^2 comprising 27% of the total zooplankton. Other differences between Patalas (1969) and this study are not so great. He encountered slightly more *E. coregoni* and *D. retrocurva* and slightly lower percentages of bosminids with mucro and *C. lacustris*. When the data for this study are calculated for Patalas' (1969) sampling period, the above differences still exist, but in slightly different percentages. It is expected that there would be more bosminids with mucro and *C. lacustris* nearshore than in the lake as a whole. However, it is surprising that Patalas (1969) found more *D. retrocurva* in his lakewide study than were found in nearshore waters, the apparent preferred habitat.

Because there was a much greater increase from the minimum to the maximum concentrations of total zooplankton and of most of the common identification groups at the 1/2 km stations than at the 4 and 8 km stations, it is obvious that the waters closer to shore are relatively more productive. McNaught and Buzzard (1973) concur. The nearshore waters warm more quickly and completely. Patalas (1969) suggests a relationship between zooplankton abundance and heat content of the water. Further, the nearshore areas tend to support greater phytoplankton growth due to a higher nutrient level there; thus with a more abundant food supply there tend to be more zooplankters (Gannon 1972). The higher numbers of bosminids than daphnids nearshore may be a result of size-selective predation (Galbraith 1967; Brooks 1969).

There are some apparent differences, and probably many subtle differences, in the distribution of zooplankton at the different stations. At 1/2 km from shore the common copepod identification groups with the exception of *T. prasinus mexicanus* reached their single greatest concentration (as opposed to the highest average level during a cruise for all 7 stations a given distance from shore as discussed hitherto in this report) at Station 222 (Table 9). The cladocerans with the exception of *E. coregoni* attained their greatest density at Station 231. It was at Station 231 that the highest concentration of any group in the entire study was observed (352,956/m^3 for bosminids with mucro in late September). When the three highest single values at 1/2 km are considered for the common identification groups and for mean total zooplankton at each station, it is obvious that the stations off the Welland Canal (210), Niagara River (207), and just to the east of the Niagara River (213) supported the least zooplankton. Thus at 1/2 km from shore where depth was relatively constant for all 7 stations and therefore does not bias the interpretation of results expressed as concentration per unit volume, it appears that probably the Welland Canal and Niagara River waters had an inhibitory effect on abundance of zooplankton in the western part of the study area closest to shore. The Genesee River did not seem to exert a similar negative influence on zooplankton.

At 4 and 8 km from shore the stations are not depth-comparable. When the data are expressed as concentrations per unit volume (Table 10), most of the common identification groups experienced their three single highest densities at both ends of the sampling area, at Stations 202, 203, 244 and 245, in the areas off the Welland Canal and the Genesee River which are among the shallowest at 4 and 8 km. In addition, at 4 km from shore some of the three single highest concentrations for some groups were at Stations 208, 233 and 238. At 4 km the three greatest concentrations per cubic meter of total zooplankton were at Stations 244 (first), 208 (second), and 202 (third) (Table 13). If the data are expressed as numbers per square meter, the three maximum values were at Stations 223 (first), 232 (second), and with about equal values at Stations 238 and 244 (third). At 8 km from shore, the three highest levels of total zooplankton per cubic meter in decreasing order were at Stations 245, 203, and about equal levels at Stations 239 and 209 (Table 13). In terms of total zooplankton per square meter, the three highest values in decreasing order were at Stations 203, 233 and 239. Considering both numbers/m^3 and numbers/m^2, certainly at 8 and probably at 4 km from shore the Welland Canal and Niagara River waters were dissipated and did not inhibit the zooplankton.

Schindler and Noven (1971) have stated that the occurrence of male caldocerans in late fall is apparently unusual in North America. Contrary evidence from the Great Lakes is beginning to accumulate with this study and those of Roth and Stewart (1973) and Nauwerck et al. (personal communication)*.

There is a great need, also voiced by McNaught and Buzzard (1973) and Rolan et al. (1973) to study copepod nauplii and the resulting immature copepodids. The juveniles are many times more abundant than the adults upon which sole attention has been focused for so long. The younger forms belong to individual species and should be counted as such, just as the immature instars of cladocerans are identified to species. In view of the relatively wide range of sizes during the 12 developmental stages of copepods, it would be good not only to identify the young to species, but also designate each animal's life history stage. Most probably a small nauplius has a different niche than a large copepodid of the same species. For example, copepodid stages IV, V and VI (the adult stage) of *Cyclops bicuspidatus thomasi* are predaceous and their favorite prey are their own nauplii and younger immature copepodids as well as diaptomid nauplii (McQueen 1969). A method exists for identifying all Great Lakes diaptomid copepodids to species, stage, and sex (where differentiated) (Czaika and Robertson 1968; Czaika 1974b). Methods are needed for identifying cyclopoid immature copepodids to species and stage and for nauplii, although probably the best we can hope for with nauplii is identification to the generic level.

Zooplankton from the mouth of the Genesee River was 5 times less abundant than from near the river mouth in Lake Ontario (Station 243). The maximum total zooplankton during any one cruise at Station 243 was 226,172/m^3 (in late July-early August) whereas the mean maximum total zooplankton during a single cruise for all the Genesee River mouth stations was 32,873/m3 (in late August) (Table 14). Zooplankton at the mouth of the Niagara River was twice as abundant as at the closest station in Lake Ontario (Station 207). The maximum total zooplankton during any one cruise at Station 207 was 75,334/m3 (in early September). The mean maximum total zooplankton during a single cruise for all Niagara River mouth stations was 125,620/m3 (in mid-June) (Table 14). Total zooplankton in late May-early June was also high (93,042/m3).

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*Nauwerck, A., G. F. Carpenter and L. Dewey. The crustacean zooplankton of Lake Ontario, 1970. Canada Centre for Inland Waters, Burlington, Ontario. (unpublished).

The river mouth sampling schedule may be at least in part responsible for some of the zooplankton distribution patterns at the river mouths. At the Genesee River mouth zooplankton peaks occurred in late August. In southwestern Lake Ontario the major identification groups peaked a little later. There were no river mouth samples from late August to late November in the river mouth areas. Had there been sampling in September and October, perhaps the seasonal distribution of the Genesee River mouth and southwestern Lake Ontario zooplankton would have corresponded even more closely. In the late spring zooplankton from the river mouth areas was sampled at shorter intervals than zooplankton from southwestern Lake Ontario. In view of the short-lived naupliar and early copepodid stages (Robertson et al. 1974), perhaps such large numbers of the major copepod identification groups at the Niagara River mouth were encountered because the short-interval sampling was conducted just at the time of peak numbers of a late spring generation of copepods. Sampling in southwestern Lake Ontario and at the Genesee River mouth may not have coincided with a late spring maximum that nonetheless may have occurred.

Daphnia galeata mendotae was not as common in southwestern Lake Ontario or at the mouth of the Genesee River as it was at the Niagara River mouth. It reached peak numbers in late fall. *Daphnia retrocurva*, the most abundant daphnid in the entire study area, peaked in late September and was barely detectable at the level of sampling for this study by late fall. These data suggest a complementary seasonal distribution, and perhaps a somewhat complementary niche preference, of these congeneric species.

Benthos

From those stations analyzed for benthos, Stations 213 and 231 were not included in the quantitative results since only 1 sample was available for each. Station 243, which had 3 samples available, was not included since 2 of the 3 samples were small and considered to be unrepresentative. The reason for the few and apparently unrepresentative samples at these stations was the rocky nature of the substrate at the 1/2 km stations and the limited value of the Ponar dredge in sampling this type of substrata. Of the other sites examined, Stations 209, 244 and 245 were represented by 4 samples and the remainder by 5 samples.

The large numbers of macroinvertebrates noted at Stations 208, 209, 214 and 245 and the high percentage of tubificid worms at Stations 209 and 214 (94.9% and 86.9%, respectively) was believed to be due to the deposition of organic material carried into the lake by the Niagara and Genesee Rivers. There was, however, fluctuation in both total macroinvertebrates and in the percentage of Tubificidae from cruise to cruise (Figures 19-25). This was attributed to either a change of the current patterns in the lake or to the exact location from which the samples were taken, or both. It was concluded that the mean numbers and percentages noted in Figures 18-28 are representative of the predominant conditions at the areas examined.

Pontoporeia affinis (Figure 26), which is considered to be a pollution sensitive organism (Anon 1969), showed a strong relationship to depth, being approximately 16 times more dominant at the 8 km stations than at the 4 km stations. The total absence, infrequency of occurrence and the few numbers found at Stations 208, 209 and 214 when compared to Stations of similar or shallower depth seems to indicate a more polluted condition just east of the Niagara River. Stations 208, 209 and 214 were not included in obtaining the above data since they were suspected of being more polluted than the other stations examined. Since several *P. affinis* were found at the 1/2 km stations (Tables 15-19), it is believed that the total absence of *P. affinis* from Station 208 was primarily due to pollution rather than to its depth (12.8 m; shallowest of the 4 km stations).

The Sphaeriidae were relatively consistent in their association with depth; the shallower the station the greater the percentage of fingernail clams in the sample.

There appeared to be some effect of depth on both the pollution sensitive *Stylodrilus heringianus* and the pollution tolerant *Limnodrilus hoffmeisteri* (Brinkhurst and Jamieson 1971); however, the effect was considered to be relatively inconclusive. Both these species did give an indication of a greater degree of pollution at Stations 208, 209, 214 and 244. Taken on an average, these stations contained both the four smallest percentages of *S. heringianus* and the four largest percentages of *L. hoffmeisteri*.

In conclusion, there were strong indications from the benthos data that both the Niagara and Genesee Rivers carried organic enrichment and some degree of other pollutants into Lake Ontario. These affected both the numbers and the quality of the benthos primarily to the east of the river mouths. The quality of the benthos was most seriously affected below the mouth of the Niagara River where the highest percentages of tubificid worms and the smallest percentage of *S. heringianus* and *P. affinis* were noted.

Cladophora

In contrast with other areas of the Lake Ontario shoreline (Neil 1974), *Cladophora* growth in the nearshore region between the Niagara River and Rochester was low. This is particularly evident in contrast to the eastern sector of the lake. It was believed that the lack of suitable substrates was a major cause of the above rather than a shortage of nutrients or sufficient light. This was supported by the fact that in the study area where rocky outcroppings occurred, *Cladophora* growth was abundant. Between the early spring to early summer (March through June) and late summer to early fall (mid-August through September) when artificial substrates were placed in those areas where *Cladophora* growth was scant to absent, such as in regions overlain with two or more centimeters of sand, colonization by this attached alga would occur on the artificial substrate within a few weeks. Abundant growth would soon follow. No evidence of mineral deficiencies or other morphological-physical abnormalities were noted in the *Cladophora* on the artificial substrates (Storr and Sweeney 1971). This is additional evidence that lack of suitable substrates may be the major limiting factor.

The observed biomass peaks in July and October concur with the *Cladophora* observations in Lakes Michigan, Erie and Ontario by Storr and Sweeney (1971). They noted the maximum growth took place when the water temperature was between 15° and 18°C. Above 20°C vegetative growth and reproduction, both sexual and asexual, begin to slow and cease at 25°C. The photoperiod in July and mid-August also may limit growth.

These observations could have socio-economic significance. Individuals and/or agencies contemplating the construction of boat launching ramps, fishing piers or other projections into the waters of the Niagara River to Rochester nearshore zone can anticipate possible problems from the growth of *Cladophora* and other forms of nuisance attached algae. Care should be taken to reduce and/or control the growth of such undesirable plants.

CHEMICAL---SEDIMENT

Nutrients

The generally lower phosphorus content near and in the plume of the Niagara River are believed to be a function of the sandy nature of the bottom materials (Pomeroy *et al*. 1968) as illustrated in Figure 29.

The increase in sediment phosphorus in the eastern sector of the Niagara River plume was attributed to the higher concentration of aqueous phosphorus from the river itself. In the nearshore zone, Station 215 and 224 had consistently high phosphorus concentrations. These high concentrations are basically attributed to the depth at these points - 110 m and 135 m, respectively (Williams *et al*. 1970). The overall P_T concentrations at the various stations during Cruise I were higher than during any other cruise. Since the Pearson correlation coefficient (R) of P_T and percent organic carbon during this cruise was +0.81, it was believed that these high values were due to sedimented planktonic algae. The high P_{TWS} content in the sediment was attributed to the decomposition of the sedimented plankton seen during Cruise I.

Examination of the P_T results indicates that generally after the sedimenting of the plankton in the spring, the P_T of the sediment remains relatively constant from early summer to early winter.

The same situation for P_{TWS} was not applicable to the littoral zone of Lake Ontario. The P_{TWS} content during Cruise VI (Figure 31) showed a drastic reduction from Cruise III. This period from late June to mid-September 1972 represented the majority of the stratification period in the littoral zone. The thermocline was generally at a depth of approximately 20 meters at Cruise VI. With this thermocline depth, all stations from a distance of greater than 2.5 km from shore were from the hypolimnion, except near the Niagara and the Genesee River mouth areas where the 20 meter depth contour was 7.5 km and approx. 4.2 km from shore, respectively.

The bottom temperatures remained relatively constant during the course of the study at ≈4°C except at the 1/2 km contour where some temperatures of 20-22°C were noted. The percent oxygen saturation at 1 meter above the bottom ranged from >100% during Cruise III to ≈70% during Cruise VI.

Although from a statistical point of view the temperature and oxygen concentrations with P_{TWS} concentrations (R = -0.71 and R = -0.81) appear to be significant, their effects were assumed to be minimal.

This reduction is thought to be due in part to desorption from Fe complexes in these calcareous sediments despite the presence of aerobic conditions (Li et al. 1970). There also was some evidence of solubilization of sediment iron.

Two important factors in the reduction of soluble phosphorus were the nature of the bottom materials and the hydrodynamics of the system. The littoral zone of Lake Ontario is composed of gravel, sand and silt which occur as a veneer over residual glacial clay deposits (Williams and Mayer 1972). These sediments generally were unconsolidated, particularly at the 1/2 km contour and have a high water content. Under these conditions it was questionable whether the microzone barrier was effective in retarding the release of phosphorus to the overlying water (Williams and Mayer 1972). If the microzone barrier was ineffective, mixing of the interstitial waters to a depth of >5 cm (Skoch and Britt 1969) due to wave action and currents have been reported. Numerous other investigators have noted the effects of hydrodynamics on the possible release of phosphorus (Lee 1970; Pomeroy et al. 1965; Syers et al. 1973). Also, although the overlying water remains aerobic, the aerobic layer of the mud generally is thin (Hynes and Grieb 1970). This fact coupled with a weak microzone barrier and sufficient mixing could have caused the observed regeneration of P_{TWS} and solubilization of some of the Fe complexes. Generally, the total sediment iron concentrations remained relatively constant but a slight reduction in iron was noted from Cruise III to Cruise VI. The statistical significance of this reduction was, however, quite weak (i.e. poor correlations with P_T and P_{TWS}).

Biological effects also may have been a contributing mechanism to the release of P_{TWS} to the overlying water column. Harrison et al. (1972) reported that bacteria cultures (both aerobic and anaerobic) produce organic acids that sequester metallic cations and therefore were capable of solubilizing inorganic phosphorus. During the transformation of *Chironomus* species from larval to the adult form, phosphorus can be extracted from the sediment (Williams and Mayer 1972). The development of *Oscillatoria* mats will also cause an increase in the transfer of phosphorus from the sediment (Poncella et al. 1970). Munawar and Nauwerck (1971) found *Oscillatoria* in Lake Ontario, but the occurrence of this species in the littoral zone during 1972 was infrequent. Therefore, the impact of this alga was thought to be minimal.

The analyses of water samples taken at a depth of 1 meter above the bottom during the period of study indicated no significant change in PO_4. However, an increase in P_T was seen as was an increase in chlorophyll biomass. It is believed that the regenerated P_{TWS} from the sediments was assimulated by the plankton.

During Cruise IX the overall P_{TWS} concentration increased. These increases were assumed to be a function of the decomposition of sedimented plankton since the biomass during cruises prior to this were higher than during Cruise IX itself.

Analyses of sediments from Cruise XI show the P_T values to be quite similar to those found during the same period the year before (Cruise I), except for some higher values at the 8 km contour. The net effect was an increase from Cruise IX due to the sedimenting of sestonic materials through the period of winter stagnation. P_{TWS} concentrations during this final cruise show an areal increase from Cruise IX and also were seen to be approximately the same as for those found during Cruise I.

Sediment phosphorus data from the Genesee River mouth area showed no statistically significant changes with time or distance from shore. However, the sediment P_T and P_{TWS} were significantly higher at the Genesee River mouth than at the Niagara River mouth and at equivalent distances from shore in the nearshore area.

These consistently higher values at the Genesee River mouth stations were attributed to the increased clay and silt content in this area. The increased P_T values near the mouth of the Genesee River were also thought to be due to accumulated sediments which were subject to less wave action because of the natural identification of the shoreline.

Microorganisms in sediment transform organic-N to more soluble forms such as NH_4^+, under anoxic conditions, and NO_3^- under oxic conditions, which can be released to the overlying water (Lee 1970; Austin and Lee 1973). Nitrate is only added to the waters in appreciable amounts in well oxidized, stirred situations such as those occurring in shallow areas or during lake turnover (Keeney 1972 and 1973). This pattern is shown by a decrease in nitrate between Cruise I and III. During the stratified period, there was a build-up of nitrate in the sediments, but concentrations dropped off during fall turnover as seen during Cruise IX. Nitrate concentrations returned to the higher levels over the period of winter stagnation.

One way analysis of variance showed significant variation between Cruise III, the period of lowest nitrate concentration, and all other cruises. Cruise I was the only cruise to show variation between the 4 and 8 km contours. Statistically, there was no variation between nitrate concentrations during the Genesee River mouth cruises. Due to inconsistent sampling at the Niagara River mouth, only a few stations yielded results throughout the period of study and, therefore, no statistically valid relationships could be made. However, the sediment nitrate concentration did appear to be lower than the concentration in the nearshore zone sediment.

Upon preliminary analysis, there appeared to be a direct correlation between nitrate in sediment and phytoplankton. This might suggest some dynamic equilibrium between the sediment and the water with regeneration of sedimented nitrates as the phytoplankton demand for nitrate change throughout the season. However, without further intensive study, this can neither be proven nor refuted.

As previously mentioned, ammonia is the by-product of organic-N decomposition. The only significant changes in sediment ammonia concentration in the nearshore zone of Lake Ontario was during Cruise III. This probably indicated some regeneration of ammonia to the overlying water during spring turnover. The high concentration of ammonia during Cruises VI and VIII at the Genesee River mouth might possibly be due to an increased decay of sedimented phytoplankton following the spring biomass maximum.

There was significant variation between the 4 km, lower concentrations and 8 km, higher concentration contours with respect to organic-N. This is possibly a function of currents, settling rates and sediment types. Cruise III, which had the lowest mean concentration possibly due to turnover, and Cruise XI, which had the highest mean concentration, are the only two cruises which showed any variations when compared to the other cruises. In the Genesee River mouth, only Cruise V (the lowest concentrations) showed significant variation. In comparison, the Niagara River mouth showed almost no variation in organic-N concentrations.

With organic-N making up over 50% of total-N, total-N follows the same patterns as organic-N. (Figure 66)

In general, Lake Ontario Cruise III and Genesee River mouth Cruise V showed the most variation for all nitrogen forms measured. Apparently, lake turnover does significantly regenerate nitrogens to the overlying water. This seems to hold true even in the Genesee River mouth where there is no true thermal stratification. This also appears to be true for the Niagara River mouth, but only for nitrate and ammonia.

A baseline for individual nitrogen forms is not feasible because of seasonal variations. 1972 had a mean total-N range of 1.2 to 1.7, but 1973's one cruise had a mean of 2.5. Without additional cruises in 1973, it is impossible to determine an accurate total-N baseline.

Ammonia concentrations just east of the river mouths appeared slightly higher than to the immediate west. Aqueous ammonia concentrations from the rivers seem to indicate a possible deposition in these areas, Organic-N, likewise, showed this increase in sediment concentration just east of the Genesee River mouth but no water data is available to explain this.

The Niagara River mouth sediments had consistently higher carbonate carbon (CC) and organic carbon (OC) percentages found in the western zones as compared to the eastern zone. This was attributed to an increase in settling out of particulate matter and discontinuous sediment traps. A decrease in velocity and an easterly deflection of the inflowing Niagara River water caused by the crossflow of a general easterly lake current may explain the preceeding conclusions (Anon 1969). The relatively low percentages of OC found in the samples from the mouth of the river were attributed to the observed coarse grained sediments and the well oxygenated sediments (Thomas 1969; Kemp 1971). Literature values of 0.5 to 2.7% OC have been reported for the Niagara River. The upper range values were attributed to the discontinuous nature of the river bed where localized sediment traps could be found (Anon 1969). The relatively high percentages of CC found in the river mouth sediment samples are probably the result of erosion and transportation of carbonate tills by the Niagara River with a resultant deposition near the mouth of the river.

The carbonate in the sediments of Lake Ontario is believed to be mainly calcium carbonate in the form of calcite. Its origin in the lake appears to be biochemical precipitation and erosion of nearshore or shoreline glacial tills. Factors which are believed to control calcium carbonate in the sediments are hypolimnion volumes (Kemp et al. 1971) and temperature. The highest CC percentages were found in the 4 km contour samples and corresponded with a high mean phytoplankton biomass at this contour. Possible seasonal CC variations noticed in the sediment samples from the 4 and 8 km contour may have been a function of greater organic matter decay in the summer during stratified conditions creating lower pH's and temperatures, solubilizing the bound carbonates. The production of precipitated carbonates in the epilimnion which occurs during intensive algal productivity and at high pH's could mask the previously mentioned event. However, it may be possible that the precipitating solid carbonates are bound in a colloidial state or are resolubilized upon entering the hypolimnion. The major deposition of the biologically precipitated carbonates did not occur until unstratified conditions were reached. Another possible explanation for the higher carbonate values in the spring and fall would be the increased run-off carrying in carbonates from the shoreline. This pattern was not noticed in the 1/2 km contour samples. However, no conclusions could be drawn due to the limited number of samples taken from this contour.

The higest OC percentages were found in the 8 km contour samples which parallel the highest observed clay content. The decrease in OC content in the 1/2 and 4 km contour samples corresponds to the decreasing clay content. An additional reason for the low OC percentages in the samples from the 1/2 km contour is the well oxygenated sediments from which these samples were taken. The lowest OC percentages were found during Cruise I and may possibly be due to the resuspension of some organic matter during turnover. This, however, could not explain the high OC percentages observed during Cruise XI. The highest OC percentages were observed in the 1/2 and 4 km contour samples during the latter part of the stratified season (Cruise VI). The settling of organic matter would logically have reached its peak accumulation at the sediment-water interface during this period prior to fall turnover. The lack of cycling with a possible increase in OC percentages in the 8 km contour samples from Cruise I to Cruise XI may be an indication that sediments with a high clay content, and therefore a higher sorption capacity for OC, are less affected by mixing processes (Lee 1970).

The low OC percentages in the samples from Stations 202, 205 and 208 in the 4 km contour were related to the sediment type. An additional influence on Station 208 may be the impact of the high Niagara River velocity flow which keeps suspended particles from settling out and keeps the water column well oxygenated. The relatively high CC and OC percentages in the samples from Stations 211, 214, 217, 220 and 223 in the 4 km contour were related to the deposition of suspended matter brought in from the Niagara River and Eighteen Mile Creek, sediment type, and a bathymetric depression limiting mixing due to currents. Carbon percentages decreased in the samples from Stations 226 to the Genesee River. This was attributed to the sediment type and decreased loading from allochotonous sources. The exceptions to this decreasing trend were samples from Stations 229 and 232 which showed slightly increased carbon percentages. One possible factor influencing this may be the inflow of Oak Orchard and Marsh Creek. (See discussion of total organic carbon in water). The low OC percentages in the samples from Stations 218, 221, 239, 242 and 245 in the 8 km contour were related to the observed sediment type. The effect of loading by the Niagara River on the southwestern nearshore sediments is dramatized by the highest OC percentages being found in samples from Station 209. The loading effect steadily decreased eastward along the 8 km contour reaching a minimum effect probably before Station 221. Carbon values by A.L.W. Kemp (1971) for Lake Ontario compare with those observed in this study of the nearshore considering the differences in location and sediment type.

The effect of the Genesee River on the lake sediments from Transect 243, 244 and 245 appeared to be minimal. This was probably related to the slow velocity of the Genesee River which deposits much of its suspended load relatively close to its mouth. In relation to the Niagara River mouth, samples from the Genesee River mouth had lower CC percentages. This was probably due to the decreased erosion, transportation and deposition of carbonate tills. The relatively higher OC percentages were due to the observed increase in silt and clay in the river mouth sediments, a greater organic loading and a characteristic bottom, shoreward current flow in the Rochester embayment area (Casey et al. 1973).

The mean organic carbon/organic nitrogen ratios (OC/ON) for the Niagara River mouth sediment samples was 8.6, for the nearshore lake sediment samples it was 8.1, and for the Genesee River mouth sediment samples it was 11.5. The nearshore ratio is comparable to the 8.2 ratio reported by A.L.W. Kemp (1971) and A.L.W. Kemp and A. Madrochova (1972) for Lake Ontario. It is believed that the higher the OC/ON ratio, the greater is the organic matter transformed and stabilized. This transformation and stabilization process is due to the reworking of the sediments, preferential decomposition of protein containing material with subsequent release of nitrogen, a slow sedimentation rate (Kemp 1971; Kemp et al. 1971), and the amount of oxygen in the water column.

It has been estimated that 90% of the organic matter in Lake Ontario is autochothonous and only 10% allochotonous (Kemp et al. 1971). The nearshore study zone may have a larger allochothonous contribution since it is affected to a greater extent by run-off and river input. The direct and indirect use and release of carbon in the sediments as a nutrient is dependent upon sediment type, sedimentation ratio, pH, Eh, temperature and the amount of sediment mixing both hydrodynamically, biologically and chemically. It is not certain to what extent the carbon in the sediments acts as a nutrient source in the carbon cycle. However, portions of the study zone could possibly act as a carbon sink. A baseline range for carbon in the surface sediments for the nearshore zone is 0.3 to 2.0% C at the 1/2 km contour, 0.3 to 5.2% at the 4 km contour and 0.4 to 5.5% C at the 8 km contour.

Toxicants

Discussion of sediment heavy metal concentration involves exclusion of measurements of Mg, Fe, Mn, Zn and Ni concentrations on samples from Cruises I and III of the Niagara River mouth due to a lack of sufficient number of reliable measurements (less than four values). The same metals are not discussed for concentrations measured on samples from Cruises I and V of the Genesee River mouth. Measurements of Fe and Ni concentrations on samples from Cruises I and III of Lake Ontario, as well as measurements of Cd concentrations on samples from Cruise I are also excluded from discussion. Poor detectability, low reliability and inconsistencies with the other data reported are the reasons for suspect and subsequent elimination.

Table 54 lists overall sediment heavy metal concentration averages for the Niagara and Genesee River mouths as well as for Lake Ontario. These averages could be used to characterize the overall distribution of heavy metal concentrations in the sediment. However, they do not reflect the variability found between averages found during the different cruises. The averages found for the Niagara and Genesee River mouths were often too low to suggest an actual percentage variation between them. The greater number of samples measured and generally higher concentrations for the Lake Ontario nearshore did allow estimation of percent variation from the mean of the cruise averages.

Concentrations of magnesium in the Niagara River mouth were quite variable. The values seemed to be questionably high. Nickel concentrations were also quite variable. Average chromium and iron concentrations were variable but conclusions made with these averages are considered valid. Manganese and zinc concentrations had relatively constant averages. Averages of mercury, copper, cadmium and lead concentrations varied only slightly and were generally around the limits of detectability.

Except for measurements from Cruise III, average magnesium concentrations in Lake Ontario sediments varied less than 5% from the average mean. Average nickel, chromium, iron and zinc concentrations were also quite constant and varied only about 10%. Manganese and mercury values were quite variable with about 40% deviation. Copper, cadmium, and lead values varied only 20%.

Average nickel concentrations in sediments of the Genesee River mouth were quite variable. Magnesium, chromium, iron, and manganese values were fairly constant and zinc values were almost exactly the same, varying less than 1%. Mercury, copper, and lead values were generally very low and varied only slightly. Averages of cadmium concentrations were also quite low, but were quite variable.

Overall, the variance in the averages of all the metal concentrations was small enough so that valid conclusions could be made based on the mean of the average concentrations. The Niagara and Genesee River mouth sediments were more variable than the Lake Ontario sediments.

An overall pattern of heavy metal concentrations in the sediments of the Niagara River was not evident. However, there was one area of high magnesium, iron and manganese concentration. This appeared at Stations 374 and 377 in the center of the river mouth for almost all of the cruises. Station 373 immediately to the west of them was generally of much lower concentration. Stations 369 and 366 further west were not usually sampled due to the compact nature of the sediment. This pattern suggests some possible deposition at this point.

A slight areal distribution pattern was found for manganese, zinc, lead, copper and cadmium concentrations in the sediments at the Genesee River mouth. The mouth Stations 351 and 352 generally had higher concentrations of these metals. This area of higher concentration extended north to Stations 358 and 362. The silty nature of all the stations seemed to indicate rapid deposition of particulate matter as the river interfaced with the lake.

Overall averages were calculated for all the metal concentrations in the 4 km contour and in the 8 km contour (See Table 54). Iron and manganese concentrations were higher in the sediments of the 8 km contour. This was significant during each cruise as well as overall. Iron averages were about 35% higher and manganese averages were about 65% higher. This same pattern was found for phosphorus in the sediment. This seems to be the result of deposition of sestonic and particulate inorganic matter as you go further offshore. The relationship between iron and phosphorus is well known. Magnesium, on the other hand, was about 25% lower in the 8 km contour than in the 4 km contour. Although the contribution would probably be small, it was also noted that chlorophyll-a in water was higher in the nearshore 1/2 and 4 km contours. Overall averages for Zn, Cr, Cu, Cd, Pb, Hg and Ni indicate that distance from shore had little effect on their distribution. The averages were almost identical for most of the metals.

Also in Table 54 averages are shown for what is described as the western section and the eastern section of the neashore area of Lake Ontario (See map in Figure 67). Manganese and cadmium seemed relatively constant with no apparent differences between western and eastern sections. Magnesium concentrations were approximately 25% higher in the western section. Iron and nickel values were significantly higher in the western section by approximately 35 and 40%, respectively. The rest of the metals, Zn, Cr, Cu, Pb and Hg were definitely higher in the western section by over 70%. Chromium values were almost two times higher. This indicates a positive impact from the Niagara River on metal concentration in the nearshore sediment of Lake Ontario.

The averages found in Table 54 do not provide a complete or accurate description of the distribution of heavy metals.

Table 55 provides averages for specific areas which were found to be prominent in the cruise by cruise data. Stations involved in these sometimes shifting areas are listed in Table 56 with approximate locations illustrated in the map in Figure 67.

These significant areas were found consistently throughout the study. Two areas of generally low concentration (for all the metals measured) were found near the Niagara and Genesee Rivers. For convenience, these were called the "Niagara River section" and "Rochester embayment section." Besides being of low concentration, they were of approximately the same concentration. The most evident area found was the zone of high concentration in the western section. The values were two to four times higher than those found in the "Niagara River section." Generally, the highest values found for each cruise were located in the western section. The size of the area varied somewhat for each metal, but there was no consistency in this variation. Individual values at Station 203 varied frequently so that it was included in calculation of averages at times for the "Niagara River section" and at other times for the zone of high concentration section. Another area consisted of four very deep 8 km stations (with an average depth of 123 meters). This area often contained the second highest heavy metal concentrations, but usually were just slightly higher or the same as the whole eastern section. The last area was often similar in concentration to the deep 8 km section described above and consisted of the majority of the whole eastern section. Only the stations in the "Rochester embayment" were not in this "eastern mid-lake and deep-lake section". Metal concentrations seemed to be randomly distributed throughout this section.

Manganese was the only exception to the zone of high concentration. The "deep 8 km section" contained (on the average) the higher manganese concentrations. The most significant distribution pattern for manganese was the overall comparison of 8 and 4 km concentrations. However, the "Niagara River section" and the "Rochester embayment section" were areas of low concentration as found with the other metals. The strongest areal distribution pattern as described was found for iron, chromium and lead concentrations. Zinc, copper and nickel followed the pattern well, with only slight differences between the "deep-lake section" and the "eastern mid-lake and deep-lake section". Mercury values followed the pattern except that the "eastern mid-lake and deep-lake section" contained slightly higher concentrations than at the "deep 8 km section". Cadmium and magnesium values agreed with the zone of high concentration in the western section and with the low concentrations found for the "Niagara River section". They were quite constant throughout the rest of the lake.

The impact of the Niagara River on heavy metals concentration in the sediments of Lake Ontario becomes apparent when observing Tables 54 and 55. The Niagara River mouth contained the lowest concentrations. This was probably due to its rapid current. The compaction and sandy character of the sediment were also results of this current. The "Niagara River section" is immediately adjoining the Niagara River mouth and in part is affected by the river current. This section was slightly higher in Fe, Zn, Cr, Cu, Pb and Hg. There was about the same Cd and Ni concentrations as in the Niagara River mouth. The average concentration of Mn was slightly lower. Magnesium values in the Niagara River mouth were questionably high. The succeeding area was the zone of high concentration. This area was approximately constant in depth at 73 meters. This could be indicative of a deposition pattern as well as a mixing pattern for the river and lake currents. The highest values were found in this area. The rest of the lake measured was of considerably lower metal concentration. Low values occurred in the "Rochester embayment section". The west-east distribution pattern also indicates a positive influx of metal concentration from the Niagara River.

Comparing the Genesee River mouth to the "Rochester embayment section", there appeared to be slightly higher Fe, Mn, Zn, Cr, Cd and Ni concentrations in the mouth. Concentrations of Cu and Pb were approximately the same. There were slightly lower values for Mg and Hg in the Genesee River mouth than in the embayment section. The Genesee is a slower river with a high silt load. Deposition occurs sooner and closer to the mouth than with the Niagara River mouth. Differences of sediment type were indicative of this physical characteristic of the Rochester embayment areas.

Quality Indicators

At the Niagara River mouth and at nearshore stations near the river mouth, the sediments have a high percent dry weight and corresponding high fixed and low volatile solids percentages. These results are a function of the sandy nature of the bottom in these areas (Rukavina 1969). Sand has been reported as low sorbed or organic materials. These results indicate low water porosity and low chemical sediment activity (Berner 1971). The porosity at the Niagara River mouth averaged 0.76 in a range of 0.75-0.77. Those nearshore stations near the Niagara River were also low (0.77-0.79).

The remainder of the lake stations show the low percent dry weights and higher percent volatile weights. These results are based on the changes in sediment type. The lake stations outside the 1/2 km contour were more of a silty-clay which has a greater sorption capacity than do the sandy-type sediments, as indicated by the increase in volatile solids (organic matter) with distance from shore.

The impact of the Niagara River on sediment quality was also noted. Those stations east of the river have the highest porosities, especially at the 4 km contour, and decrease steadily moving to the east. The same was noted for the percent volatile solids.

At the Genesee River mouth station and at those nearshore lake stations in that area, the percent dry weights were comparable to those found at 4 km but were less than those at the Niagara River. This was also a function of sediment type. The percent fixed and volatile weights are also comparable to those found at the 4 km contour but are equal to those values determined for sediments for the Niagara River stations. Since the sediment porosity was higher at the Genesee River mouth stations (0.79), it can be said that this area has a capacity for even greater sorption of organic material (>4.5% level).

CHEMICAL---WATER

Nutrients

The overall average P_T concentration for the surface waters of Lake Ontario during IFYGL (1972-1973) was 0.022 mg P/l. Previously, a yearly P_T average of 0.024 mg P/l was reported by Chawla (1971).

P_T was the only phosphorus form measured from the Niagara River mouth stations. These concentrations at the Niagara River mouth during the unithermal period of 1973 were comparatively higher than the unithermal period of 1972. Due to the non-phosphorus absorbing sediment of the Niagara River plume, any phosphorus loading into the Niagara River during the unithermal 1972 period, could have produced the resulting significant increase of aqueous phosphorus levels.

In the nearshore zone, the average P_T concentration remained relatively homogenous for both unithermal periods. During unithermal conditions, mixing of the surface and bottom waters occurs with only the slightest meteorological stress. The P_T concentration did increase significantly during stratification in the bottom waters of Lake Ontario. At the same time, a drastic reduction was found in the P_{TWS} phosphorus in the underlying sediments. The regeneration of phosphorus from the sediment is believed to account for the increase in the P_T concentration of the water overlying the sediments.

The P_D concentrations in Lake Ontario showed a cyclic variation. The levels of P_D were high during the unithermal period of 1972 and then decreased during stratification to one half the level of the unithermal period. The P_D concentration increased during the unithermal period of 1973 to the same level as unithermal 1972. No phosphorus build-up was observed in the water and, therefore, it's assumed that the organic phosphorus containing planktonic material settled to the bottom and was incorporated into the sediment.

Nearshore surface enrichment was prevalent all three periods. The high P_T concentrations were due primarily to the phosphorus loading of municipalities, industries and tributaries. Since the sediment of the nearshore area is predominantly sand, which is non-phosphorus sorbing, the P_T concentration was significantly higher in the water.

The P_O concentrations were much lower than the previously reported values of 0.008 mg P/l for surface waters of Lake Ontario (Shiomi 1970). Since no significant variation was observed, it is believed that an equilibrium with other forms of P existed and a constant level of P_O was maintained by the hydrolysis of other forms of phosphate to P_O in order to balance the P demand of the system.

The Genesee River passes through a highly agricultural area and agricultural run-off of phospho-organic fertilizers during the spring of 1972 could have produced the significantly higher P_T levels in the Genesee River area during the unithermal period of 1972.

The Genesee River exhibited the same average P_T concentration during both unithermal periods. Again, a definite cycle of phosphorus concentration was observed and an equilibrium between the sediment and water was maintained.

Nitrogen determinations are important since at times nitrogen can be the limiting factor in algae growth, especially in lakes with high available phosphorus (Keeney 1972, 1973) Some phytoplankton can use nitrate as their sole source of nitrogen (Keeney 1972, 1973; Casey et al. 1973). Stratified lakes can exhibit a dicotomic nitrate distribution pattern, mid-depths having higher nitrate concentrations than the surface or bottom depths (Keeney 1972). The nearshore zone of Lake Ontario showed this surface, mid-depth variation but not the bottom, mid-depth variation. This was believed to be due to the continual oxic conditions in the bottom waters where nitrates are not significantly depleted by anaerobic respiration.

The sharp decrease in nitrate concentrations in the Genesee River mouth between Cruises III and IV is believed to be due to a decrease of allochotonous nitrate inputs from the industrial and municipal discharges on the Genesee River.

Even though the magnitude of the decrease at the Genesee River mouth area for ammonia concentrations seen during the same period is not as great as the corresponding decrease in nitrate concentrations, the authors feel this too is a function of the Genesee River discharges.

The mean ammonia concentration found in the Niagara and Genesee River mouths were generally higher than those found in the nearshore zone of Lake Ontario. This was believed to be a partial explanation for higher concentrations of ammonia found in the sediments just east of the river mouths.

The 4°C isotherm (thermal bar) did not seem to affect the movement and distribution of nitrogens.

Toxicants

Minor elements such as manganese, nickel, zinc, copper, cadmium and lead, when found in trace amounts in water, can be considered to have a few beneficial properties. However, due to their cumulative ability, they can reach levels of concentration where their toxicity becomes of greater concern. Concentrations in lake waters are usually low enough so that detectability and sensitivities are directly reflected in the accuracy of the data. Although some data may contain higher than usual metal concentrations, trends and distributions were still deducible.

Cadmium and lead concentrations were measured on samples from only a portion of Cruise I on Lake Ontario. There were no apparent differences with depth for either metal. Cadmium was just above detectability with a small range of 2-9 µg/l and averaging 6 µg/l. Lead had a high average of about 22 ug/l. Cadmium has been reported in the literature as usually less than 1 µg/l; lead averages have been reported around 4 µg/l for Lake Ontario (Anon 1969). One noticeable distribution pattern for both metals was that most of the high concentrations were found west of Olcott, New York during this cruise. Averages of Stations 201 through 217 showed approximately 7 µg/l cadmium and 37 µg/l lead. Averages of the remaining eastern stations were 5 µg/l cadmium and 10 µg/l lead. This could be a direct influence of the Niagara River; however, no further samples were measured for these metals and particularly none at the mouth of the river. These same samples were measured for copper and zinc and the same distribution of high concentration found west of Olcott, New York was apparent. This section contained 22 µg/l copper and 23 µg/l zinc, while the low concentration area to the east was only 6 µg/l and 10 µg/l, respectively.

Only Cruise VI on the Niagara River mouth had water samples analyzed for metal ion concentrations. There were no apparent patterns of areal distribution for any metal ion. There was also very little delineation of concentration with depth. Manganese and zinc averaging 43 and 150 µg/l were of higher concentrations here than in the Lake Ontario nearshore samples. Nickel and copper averaging 20 and 47 µg/l were of about the same concentration as in the Lake Ontario nearshore samples. No other metals concentrations were reported on samples from the Niagara River mouth.

Manganese concentrations in Lake Ontario have been reported in the literature at less than 1 µg/l in a range up to 44 µg/l (Weiler and Chawla 1969). The nearshore Lake Ontario cruises showed seemingly high concentrations with averages ranging from 6.7 to 14.9 µg/l for the more completely analyzed cruises. Similar to the iron concentration measured, the manganese concentration appeared to decrease offshore. At the 1/2 km stations, the averages ranged from 10.9 to 24.3 µg/l. The 4 km stations showed averages in a range from 4.9 to 9.8 µg/l and the 8 km station averages ranged from 3.6 to 9.4 µg/l. Iron and manganese have been known to be directly related. Weiler and Chawla (1969) believe that natural removal of minor elements from the lakes occurs through a combination of sorption by oxidies of manganese and iron and by sorption of suspended organic and inorganic material. This might imply that besides other factors, the higher concentrations of iron and manganese in the nearshore region might have affected seemingly higher concentrations of the minor elements.

Nickel concentrations appeared to be highly variable but in a consistent manner (from cruise to cruise). Average values for the more completely analyzed cruises were in a small range of 9 to 24 µg/l. Weiler and Chawla (1969) measured an average concentration of 5.6 µg/l with data ranging from 2 to 16 µg/l. There were no distribution patterns found for nickel concentrations.

Zinc and copper were even more varied than nickel in the nearshore of Lake Ontario. Zinc averages ranged from 12 to 94 µg/l and copper averages ranged from 15 to 81 µg/l. Higher average concentrations for zinc seemed to coincide with higher average concentrations for copper. However, no direct correlation could be made, and a seasonal variation was not evident. Weiler and Chawla (1969) found the same wide variance in both metals. Zinc seemed to have a pattern (in 1968) of increasing from about 50 µg/l near Hamilton, Ontario to 95 µg/l in eastern Lake Ontario. The average zinc concentrations in their study was 71 µg/l in a range of 18 to 115 µg/l. They found higher concentrations of copper within the main body of Lake Ontario at 60 µg/l in a range of 5 to 175 µg/l in 1968. Another literature source reports our average of 15 µg/l copper with a maximum of 145 µg/l (Anon 1969). The average concentrations of zinc and copper for the surface and bottom samples were consistently similar. Values found where the two major rivers influx to Lake Ontario agreed with those found for the corresponding cruises of the river mouths.

Metal ion concentrations at the Genesee River mouth were generally higher than the Lake Ontario average concentrations and fluctuated greatly. Nickel was an exception with a relatively consistent average of 17 µg/l. Manganese and zinc were particularly higher in wide ranges of 19 to 27.5 µg/l and 67 to 190 µg/l, respectively. Copper varied slightly with high average values in a range of 49 to 78 µg/l. Weiler and Chawla (1969) reported higher values in Lake Ontario near Rochester which corresponds with these values. They reported greater than 100 µg/l zinc and 120 µg/l copper. Very little difference was found in vertical distribution. Higher values for most metals were usually found in samples for stations directly at the mouth.

The impact of the Niagara River with regards to toxicant metal concentrations is difficult to determine from the data presented. Only one cruise on the Niagara River mouth was analyzed for these parameters, and the Lake Ontario cruises were sketchy. Slightly higher values were apparent near the river input during the more completely analyzed cruises.

Quality Indicators

Concentrations of the major cations (calcium, magnesium, sodium, potassium) comprise a significant portion of the dissolved mineral quality of an aquatic environment. However, it has been found that although some of the concentrations have been increasing throughout the years (Weiler and Chawla 1969; Casey et al. 1973), the actual values were relatively unseasonal and fairly uniform in vertical distribution. Often the ranges were within the range of analytical error.

Throughout 1972 the concentrations of these four cations were relatively unchanged in the Niagara River mouth stations. They increased slightly in the spring of 1973, primarily in the surface samples. Only a few spring 1972 samples were analyzed for any of these cations so no seasonal conclusions can be considered significant. Among the cruises, particularly Cruise III, showed higher values for all four cations in the stations nearest the Canadian shore. However, most areal distribution patterns were insignificant. Cruise averages for these cations were relatively constant and ranged as follows: 35.5-37.3 mg/l calcium, 7.5-8.0 mg/l magnesium, 12.60-12.90 mg/l sodium, and 1.37-1.89 mg/l potassium (high averages of 14.60 mg/l sodium and 2.46 mg/l potassium were found in spring of 1973 and were not included in the ranges). These values were lower than other reported Niagara River data (Sibley and Stewart 1969; Meloon and Yalkovsky 1970). However, these samples were taken further into the lake where more mixing and dilution could have occurred. Compared with the corresponding averages for cruises in the Lake Ontario nearshore zone, the average Niagara River mouth values were either slightly lower or approximately the same.

Cruise I and II on Lake Ontario in the spring of 1972 were too sparsely analyzed for all cations to make any significant statements, although the highest apparent averages for calcium and magnesium were found then. After a decrease in concentration in the early summer, there appeared to be slight increases throughout the summer with potassium peaking in late summer and the other cations reaching high averages in late fall. The spring of 1973 seemed to indicate a decrease in values. It has been observed that there is little seasonal change or variation with depth (Weiler and Chawla 1969; Anon 1969) for all cations except calcium. It was observed that average calcium in the epilimnion increased from 35.8 to 37.9 mg/l, while in the hypolimnion the calcium concentration remained around 38.5 mg/l. This concentration gradient disappeared in the fall with both the surface and bottom averaging about 39.0 mg/l. It has been suggested (Anon 1969) that this could be the result of the change in solubility of $CaCO_3$ with rise in temperatures and its subsequent precipitation. The cruise averages of these cations ranged as follows: 35.8-43.6 mg/l calcium, 7.1-8.4 mg/l magnesium, 11.75-13.79 mg/l sodium, and 1.34-1.67 mg/l potassium. Literature averages for these cations were within these ranges. Weiler and Chawla in 1969 reported 40.3 mg/l calcium, 8.1 mg/l magnesium, 12.6 mg/l sodium, and 1.35 mg/l potassium. It is important to note that most of the literature values are whole lake rather than nearshore averages and their sampling was not as extensive. Generally, no areal patterns of distribution of any of the four cations were found for any cruise.

Concentrations at the Genesee River mouth varied to an extent which makes it difficult to draw any meaningful conclusions. Surface and bottom cruise averages ranged from 38.3 to 43.9 mg/l calcium, 7.5 to 9.0 mg/l magnesium, 13.15 to 15.40 mg/l sodium, and 1.36 to 2.77 mg/l potassium. These ranges seemed higher than the other areas. This could have resulted from the agricultural nature of the Genesee River drainage basin. In fact, Gilbert and Kammerer (1955) reported even higher values for the Genesee River measured at Rochester. The river mouth cruises basically contained stations in the lake proper. The two stations nearest the river (351 and 352) were consistently higher in concentration than the other stations for all four cation concentrations. In the fall of 1972, the bottom averages higher than the surface in all four cations, while in the spring of 1973 the opposite was found. This could have been just a further indication of the wide variability exhibited by these cations in this area.

Iron, in its relationship to phosphorus sorption and release with particulate matter, is considered to have nutrient relationships and is thus indicative of water quality. Iron in the sediment is released to the water by bacterial reduction in the presence of organic matter. Ferrous iron is quite soluble in water but is readily oxidized to the insoluble ferric state and thus precipitates. Lake Ontario is usually high in dissolved oxygen and thus through natural oxidation and sedimentation there should be low iron concentrations in the water.

Only one cruise on the Niagara River mouth had its samples analyzed for iron. There was no apparent areal distribution patterns of iron concentrations. The surface and bottom samples averaged about 850 µg/l which seemed quite high. This was assumed to be nonrepresentative of the area.

Iron concentrations measured on samples from the Lake Ontario nearshore cruises varied and fluctuated to such an extent that they could be considered questionable and possibly non-representative of true iron concentrations in this region. Average iron concentrations measured by cruise ranged from 32 to 336 µg/l. The most significant observation of iron distribution is the decrease in concentration with distance from shore. At the 1/2 km stations, the range was 60 to 556 µg/l. At the 4 km stations, the average iron concentrations ranged from 22 to 289 µg/l. The 8 km station averages were in a range that was closer to reported iron concentrations, 12 to 169 µg/l. Chawla (1971) reported a 1968 average concentration of 14 µg/l for Lake Ontario with some higher values nearshore. However, most of the samples were deep lake stations. The Ontario Water Resources Commission (1968) measured total iron ranging between 50 and 200 µg/l in samples taken from the middle of Lake Ontario during the winter of 1962 to 1963. An average iron concentration of about 20 µg/l for three Lake Ontario stations in 1967 have been reported (Anon 1969) during which values up to 800, 900 and 3000 µg/l were also measured. These high values agreed with the high values found for the Lake Ontario nearshore area during this study. No west-to-east pattern of iron distribution was apparent. Stations near both of the river mouth study areas were slightly higher and reflect some impact of rivers on iron concentration in the lake.

The Genesee River mouth was analyzed for iron concentration on samples from only two cruises. The surface and bottom averages ranged from 229 to 647 µg/l. These were not as high as the Niagara River concentrations, but definitely higher than those found for the Lake Ontario nearshore zone. Stations directly at the mouth exhibited the highest iron concentrations. Values for the Genesee River at Rochester in 1963 were reported to be 280 µg/l (Gilbert and Kammerer 1965). In the fall of 1972, the average bottom iron concentration was higher than the average for the surface. As with calcium, magnesium, sodium and potassium, this pattern reversed in the following spring where the surface was greater than the bottom. Insufficient and incomplete information disallows any pattern to be established to explain this phenomenon.

The total organic carbon (TOC) in the water is the sum of all the particulate (POC) and dissolved (DOC) organic carbon. It gives a gross indication of aquatic activity. The TOC is a direct energy source for some forms of aquatic life (i.e. bacteria and zooplankton). The excess portion of TOC is either degraded and oxidized back to the inorganic carbon pool or sedimented. The POC fraction is made up from the detrital material of all the aquatic flora (i.e. algae), fauna (i.e. zooplankton), allochotonous material and resuspended sedimented POC. The DOC fraction is made up from the digested soluble organic matter of aquatic and benthic flora and fauna and the POC fraction, which becomes degraded and solubilized.

No seasonal variations in TOC for the Niagara River were noted due to the lack of retrieved data. However, the relatively high values observed during Cruise I may be due to the increased productivity during this time of year. The higher surface values at the central stations of each contour gave evidence that the thrust of the Niagara River kept the TOC (POC fraction) from settling out. The generally higher TOC values in the bottom samples from the western section of the river mouth were attributed to the complete mixing in the water column and the resuspension of organic carbon from the sediments. Since the eastern and central sections have a rocky bottom, resuspension was not possible; therefore, the generally lower bottom TOC values. It appears from the limited data that the Niagara River had a minimal contributory input of TOC into the nearshore zone except possibly during spring and other productive periods.

In the nearshore zone, no seasonal trends could be definitely established due to the lack of and patchy values of the STORET retrievable data. It was observed that the highest TOC occurred during the early spring season. This correlates with the onset of high productivity. During Cruise I, the thermal bar may have played a role in retaining some of the TOC to the inshore stations. However, the thermal bar effect could not be applied to the bottom TOC data of this cruise or to the 1973 early spring TOC data. The contour and station means at both the surface and bottom seemed to indicate that the TOC was well mixed during the unstratified seasons. Also, the slight mean TOC decrease with depth and distance from shore was related to the aquatic and benthic activity decreases with depth and distance from shore. The trend noticed at Stations 219-230 in which the surface TOC concentrations were consistently higher than the bottom TOC concentrations may have been due to decreased resuspension of sediments. This may have been a function of increased depth, decreasing current action and/or % clay concentrations, decreasing desorption and/or lack of mixing due to the inflow of a large, turbulent river. Although the rivers did not appear to be the major source of TOC, their nutrient contribution enabled higher productivity in the nearshore stations adjacent to their inflow causing higher TOC concentrations. The high TOC concentrations at Stations 201 and 202 were related to the nutrient input of the canal, Stations 206 and 215 to the Niagara River, Station 217 to Eighteen Mile Creek, and Stations 228, 229 and 230 to Oak Orchard Creek.

The TOC data retrieval for the Genesee River seemed to indicate it had a minimal direct contribution of TOC into the nearshore zone. This may be related to the settling out of much of the TOC into the embayment area due to the low flow velocity of the river.

As the most reactive non-metal, fluorine is never found in nature but it is a constituent of fluoride or fluorspan, calcium fluoride in sedimentary rocks and also of cozalite, sodium aluminum fluoride in igneous rocks (McKee and Wolf 1963). In aqueous solution it is always in the fluoride state. Generally, fluoride is a poison; however, the beneficial nature of fluorides have long since been recognized.

The concentration of fluoride in the study area was low. At the Niagara River mouth stations, the fluoride content was greater than at any other area and quite consistent for those values reported over the course of the study. The fluoride levels in the lake were quite consistent in the epilimnion waters. A significant decrease was seen with depth in the spring of 1972. Generally, the lowest values found were at the Genesee River mouth stations and at the eastern-most end of the study area.

At the three different areas, the fluoride levels in water were quite consistent and showed little or nor delineation with depths. However, a definite west to east decrease was seen in the fluoride concentrations. It is believed that the Niagara has a definite impact on the study area.

Lake Ontario has a relatively high chloride level, partially a result of its being the downstream lake. The principle sources of chloride to the Great Lakes are industrial and municipal pollution, which includes the practice of spreading salt on the roads in winter for ice control. Also contributing to the total chloride content, but to a lesser degree, is groundwater from shale bedrock areas underlaid with NaCl beds (Wyeth 1974). This geomorphology is practically evidenced in the Niagara River watershed.

An examination of the literature shows that the higher inshore values and the higher average values in the western end of the study area are consistent with other data (Casey et al. 1973). The general increase in the nearshore stations with distance from shore is statistically significant but appears to be an anomally. Consideration of all data collected after variance analysis shows no statistically significant difference in the Cl^- data recorded in the area from shore to 8 km offshore.

It has been reported that Cl^- content of the lake has been increasing since the 1900's. Since no samples were collected by the GLL outside of our study area, it is not possible to evaluate this trend. However, the average Cl^- in the nearshore area was 27.1 2.0 mg/l which appears to be higher than those values reported from 1965 (Casey et al. 1973).

Sulfates occur naturally in most waters as a result of leachings from gypsum and other common minerals. They may also occur as the final oxidation state of sulfides, sulfites and thiosulfates, and as the oxidized state of organic matter in the sulfur cycle. The sulfate ion concentration in natural waters vary from several to several thousand parts per million (Lambert 1972).

The GLL results for sulfate content in the study area indicates that the lowest values were found at the Niagara River mouth stations and the highest were found at the nearshore stations. The only data retrieval was for spring and summer of 1972.

The average values were subjected to chi-squared analyses to determine significance. The results from the Niagara River mouth stations were in themselves not significantly different, but are shown to be statistically lower than at the Genesee River mouth and the nearshore stations. No statistically valid vertical distributions were ascertainable.

At both the nearshore stations and the Genesee River mouth, a significant increase was seen for spring to summer 1972. This effect was also seen in Mortimer's experiment (1941 and 1942) with Windermere mud. He found that sulfate increased in concentration in the aerated water over mud which retained an oxidizing microzone at its upper surface. The meaning of this change was not elucidated. It is believed that the difference in sediment type at the Niagara River mouth was the primary reason for the absence of this increase in that area.

The International Lake Erie and Lake Ontario, St. Lawrence River Water Pollution Boards (1969) in their report to the I.J.C. and Chawla (1971) spoke of the increase in SO_4 content of Lake Ontario since 1900. During GLL's study, no middle lake samples were collected, but the samples analyzed from this nearshore area seem to imply that this increase is continuing.

In comparison of the STORET retrieval results, it can also be noted that the SO_4 levels found in this nearshore area are significantly higher than the values found in the middle lake by other IFYGL investigations.

Silica, never found in aqueous solutions as an element, occurs in the oxidized state as colloidal silica and/or sestonic mineral particles. The principal natural sources of silica in Lake Ontario are probably the clay minerals (aluminosilicates) and diatom skeletons. The solubility of silicates is directly proportional to pH. The GLL results of higher values at the lake stations and lower values at the river mouths are consistent with the literature (Casey et al. 1973).

During the spring of 1972 at the Niagara River mouth stations, the low dissolved silica concentrations were seen to be directly related to the low diatom biomass (i.e., no available silica). However, at the nearshore stations of the lake, a higher diatom biomass was found with a corresponding increase in dissolved silica (sampling was before any significant silica depletion). The higher dissolved silica in the bottom water was believed to be a function of regeneration of silica from the upper sediment. At the Genesee River mouth during this same period, the diatom biomass was again high and because of the higher temperature, the dissolved silica was already showing signs of depletion. During the stratified period, the dissolved silica at the Niagara River stations had increased from the spring but were still lower than the lake stations. This increase may be due to even fewer diatoms than seen in the spring. In the nearshore stations, there is evidence of some depletion during the spring period (~15%) and during thermal stratification. There was no silica regeneration from the bottom waters to the epilimnion. This depletion, however, was not unexpected.

Again, the bottom waters were significantly higher in dissolved silica. The Genesee River mouth stations showed no change in dissolved silica from the spring to the summer of 1972. The generally higher values for silica at the Genesee River mouth area (compared to the Niagara River area) were considered to be a function of the intense agricultural activity in the drainage basin of the river.

The overall increase in silica content with distance from shore, particularly in the bottom waters, was believed to be principally a function of sediment type.

Within any particular cruise of the Niagara River mouth sampling stations, the chl-a values were fairly uniform from station to station. This uniformity was present regardless of station or sampling depth. The lack of significant difference in chl-a between stations or depths is most likely related to the river plume. The turbidity in the portions of the plume that were sampled appears to obscure all chlorophyll variation among the individual stations at the river mouth.

The most common trend encountered at the lake sampling stations was the decrease in chl-a concentration with increased distance from shore (Figure 58). These findings agree with studies performed by Glooschenko et al. (1972) and Glooschenko et al. (1974b). The extremely high chl-a values found near the Genesee River mouth stations during Cruises III and IV were excluded from mean calculations since they were atypical in contrast to the overall nearshore values. Although these values were very high, they are believed to be fairly representative of the Genesee River mouth area during the sampling periods. Further examination of pertinent data at these stations yielded supporting evidence to their accuracy. At these stations, the light transmission dropped off very rapidly at the 1 meter depth.

It was also noted that the pH at these stations was high (≥ 9.0) during this time period. Each of these findings suggests high phytoplankton production and therefore high chl-a concentrations during Cruises III and IV. Additional support for this supposition is found in the phosphorus loadings during this time period. During these cruises the phosphorus loadings were the second greatest of the study period (Casey and Salbach 1974). This may be due to the after effects of Tropical Storm Agnes which passed through the region during late June to early July of 1972. The possibilities of an analytical error or the sampling of a phytoplankton patch, as discussed by Glooschenko and Blanton (1974), are not likely since the high chl-a values were found in the same area on separate cruises.

The results from Cruises VI, VII and VIII were unusual since the mean chl-a values found at each contour were essentially equal. This is believed to be due to the higher concentration of phosphorus found in the water during these cruises. The apparent decrease in chl-a concentration which occurred between Cruise VII to Cruise VIII is believed to be due to the fall overturn. During this time, higher chl-a concentrations from the surface waters were mixed with relatively unproductive bottom waters resulting in uniform and lower chl-a concentrations. The results of such physical changes is illustrated in Figure 61.

The seasonal, vertical profile of chl-a at the selected 8 km stations is shown in Figures 59 and 60. The uniform chl-a concentrations found during the spring periods were attributed to mixing of the various depths due to unithermal conditions (Figure 59). The results from Station 245 during the spring of 1973 indicate that stratification may have been present at this time. The decrease in chl-a with increased depth appears to be characteristic of stratification as can be seen in Figure 60. We expected that the waters at Station 245 would become stratified much earlier than the other stations since it was relatively shallow (44 meters) as compared with the average depth (107 meters) of the other three stations. Figure 60 clearly illustrates decreased chl-a with increased depth during thermal stratification. The lower chl-a concentrations found at the 1 meter depth are believed to be due to chl-a bleaching at high light intensities as discussed by Glooschenko and Blanton (1974). An examination of the chl-a distribution at these stations during the fall overturn period shows uniform chl-a concentrations throughout the water column. This is the same pattern that was found during the spring periods. This also was attributed to mixing of the epilimnetic and hypolimnetic chl-a to yield a uniform chl-a vertical distribution. A more detailed vertical distribution of chl-a for Stations 224 and 233 can be found in Figure 61. This figure illustrates relatively uniform chl-a at the various depths during the spring and fall turnover periods at both stations.

One of the more outstanding trends isolated from this data was the influence of the spring thermal bar on chl-a development, both vertical and horizontal. Figures 62 and 63 depict the movement of the spring thermal bar in 1972 and 1973 and its relation to chl-a development at a 1 meter depth. Although the thermal bar is depicted as a defined line, it should be noted that the thermal bar is actually a zone of 4°C water. The line which is plotted merely represents the projected center of this zone. Figure 62 shows higher chl-a development shoreward of the thermal bar during Cruises I and II. As the thermal bar movement extends further from shore, so does the area of higher chl-a values. The data in Figure 63 illustrate the same pattern for the spring of 1973 during Cruises XI and XII. The general influence of the thermal bar is evident in Figure 58. A comparison of contour means between Cruises I and II shows an increase in chl-a development at the 4 km contour from Cruise I to Cruise II. The chl-a concentration of the 4 km contour during Cruise II was almost as high as the 1/2 km mean. During Cruise I the thermal bar was generally located between the 1/2 and 4 km contour. During Cruise II the thermal bar had advanced so that it was generally between the 4 and 8 km contour. The chl-a concentrations quite obviously reflected this movement. The same pattern can be seen between Cruise XI and XII which took place during the spring of 1973.

Figures 64 and 65 show the relationship between the horizontal as well as the vertical distribution of chl-a to thermal bar movement. In Figures 64 and 65, four selected transects (201-203, 222-224, 231-233 and 243-245) were examined during Cruises I and II. The black bar used in the figures represents the approximate positions of the thermal bar during the specific cruise. No data were available for Station 201 during Cruise I (Figure 64). During both Cruises I and II, the thermal bar was located between Stations 202 and 203. The higher chl-a development on the shoreward side of the thermal bar was quite pronounced. This higher development was believed to be due to the thermal bar acting as a nutrient barrier which concentrated nutrients in the shoreward waters. During Cruise I at Transect 222-224, no thermal bar was present and the chl-a values were low and uniformly distributed. The thermal bar during Cruise II at this transect was located between Stations 223 and 224. Once again the higher chl-a concentrations on the shoreward side of the thermal bar was evident. The chl-a values on the lakeward side of the bar were low and uniformly distributed. The same general pattern can be seen in Figure 65. During Cruise II at Transect 243-245, the thermal bar was projected to be outside the study area. Examination of the chl-a values at this transect suggests that stratification had developed within this area. Examination of temperature data for this transect during Cruise II substantiates that the area was definitely thermally stratified. This is very likely due to the shallowness of these stations.

Since relatively few samples were taken at the Genesee River mouth stations as compared to the lake or Niagara River mouth stations, the significance of results is greatly reduced. The mean chl-a concentration at a one-meter depth at the Genesee River mouth was 12.4 µg/l. Other depths sampled reflected similar chl-a values which may be caused by mixing at the river mouth. The Genesee River mouth chl-a values appear to be higher than either the lake stations or the Niagara River mouth values. This may be due, in part, to the nature of the drainage basin of the Genesee River. The Genesee River watershed consists primarily of agricultural land which produces a generally more nutrient rich runoff. From the limited data available, it is not possible to isolate a trend regarding distance from shore or river mouth to chl-a concentration. The apparent difference between the western and eastern sectors of the river mouth may possibly be due to eddying of Genesee River water in the western sector. Since the samplings are so few, it is also possible that there is no real difference between the two sectors. As previously mentioned, the samples from the lake stations in the vicinity of the Genesee River mouth yielded very high chl-a concentrations during Lake Cruise III. Unfortunately, data at the Genesee River mouth stations were not available for the same time period. Further study of the Genesee River mouth is necessary before any definitive conclusions can be ascertained.

SECTION VI

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APPENDIX A

FIGURES

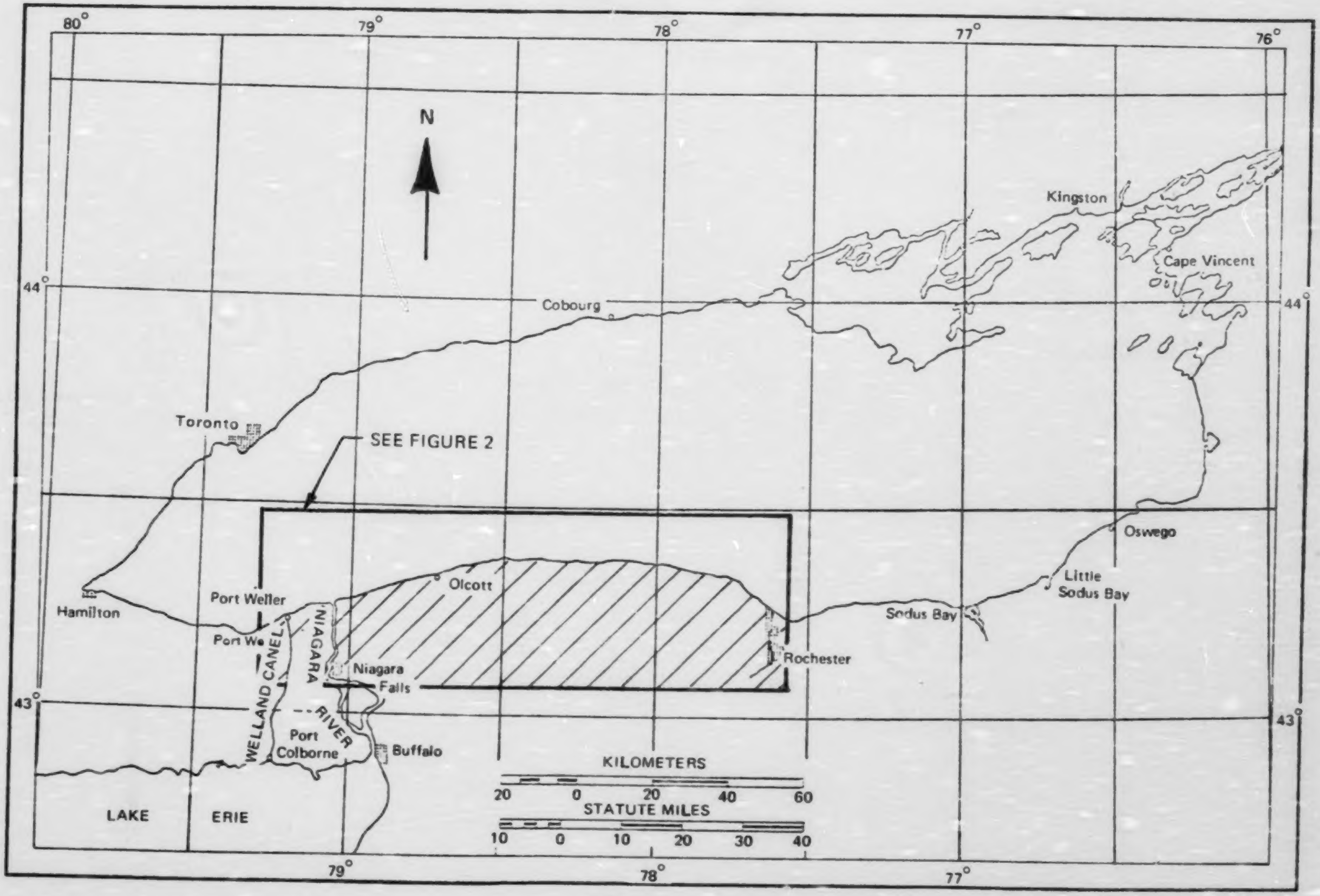
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FIGURE 1
Overall map of Lake Ontario

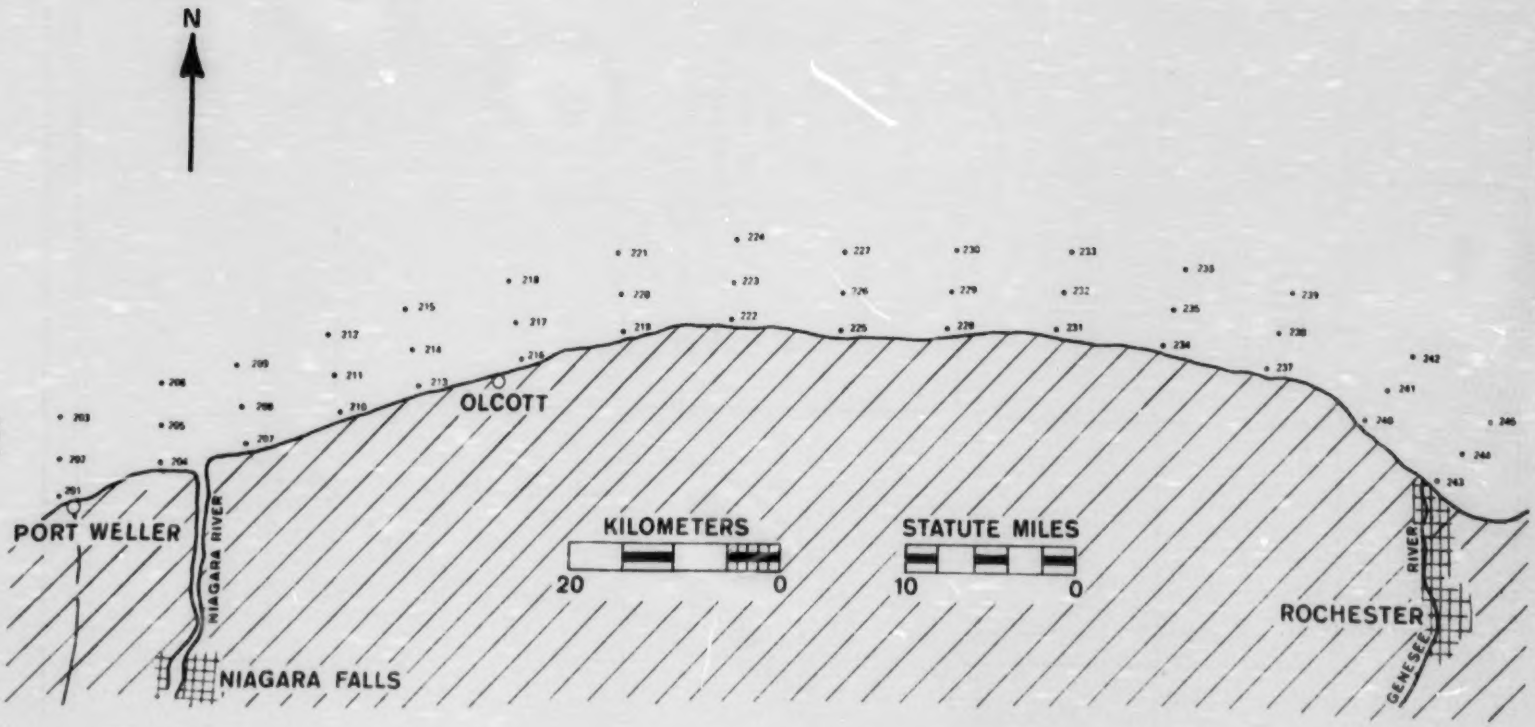
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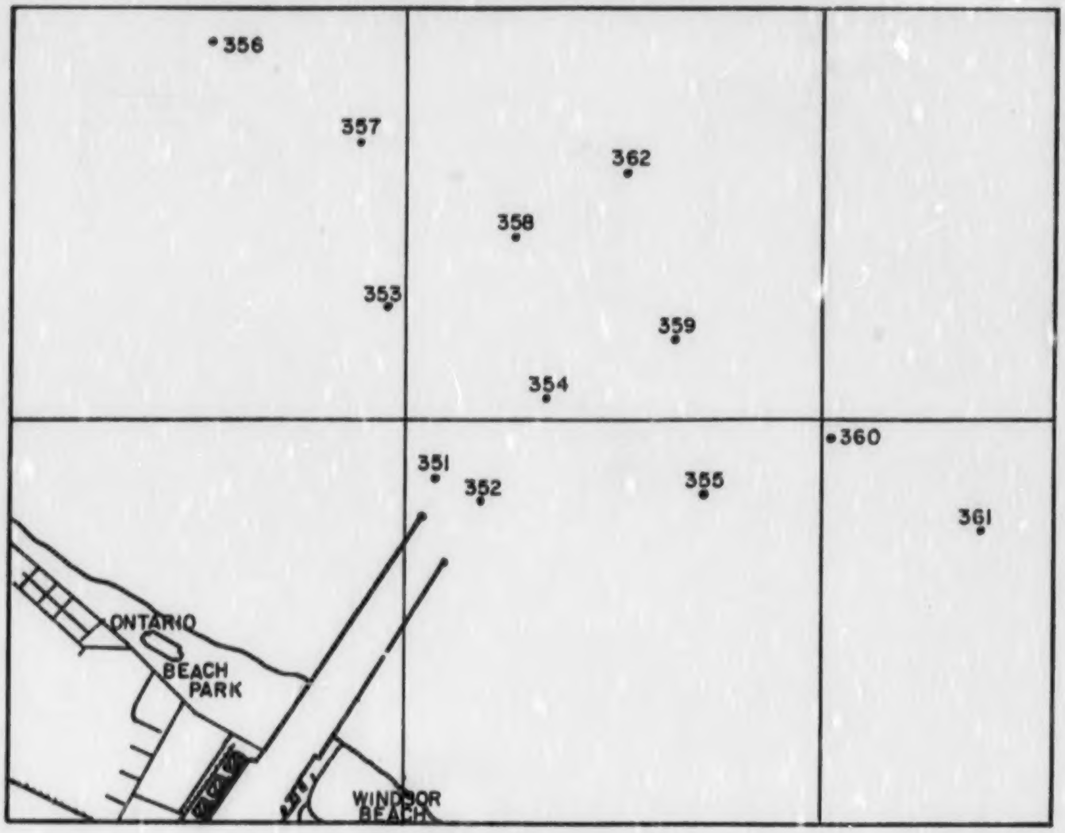
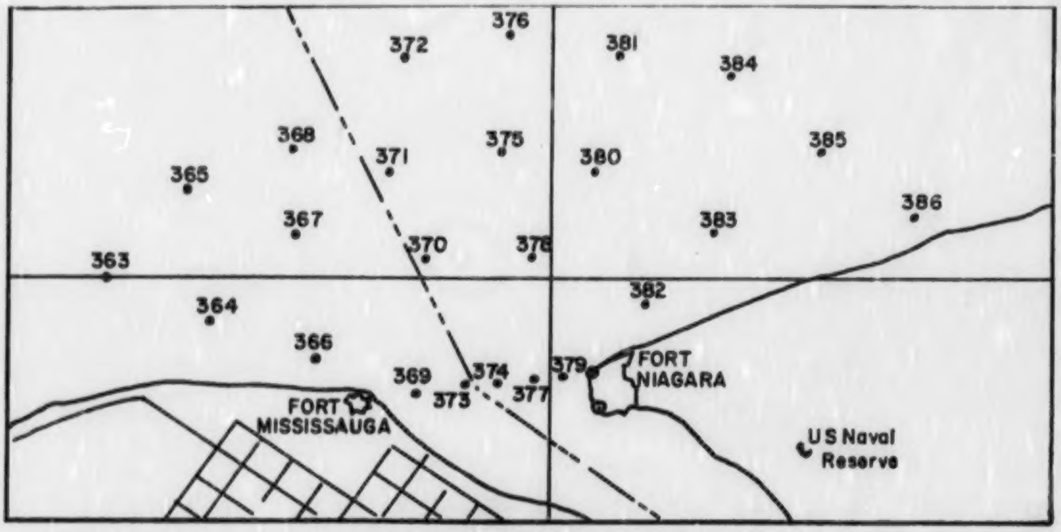
FIGURE 2
Southwestern study area with stations


356
357
362
358
353
359
354
360
351
352
355
361
ONTARIO
BEACH
PARK
WINDSOR
BEACH

GENESEE RIVER MOUTH


376
372
381
384
368
375
371
380
385
365
367
383
386
370
378
363
382
364
366
369
374
373
377
379
FORT
NIAGARA
FORT
MISSISSAUGA
US Naval
Reserve

NIAGARA RIVER MOUTH

Figure 3. Genesee and Niagara River mouth stations

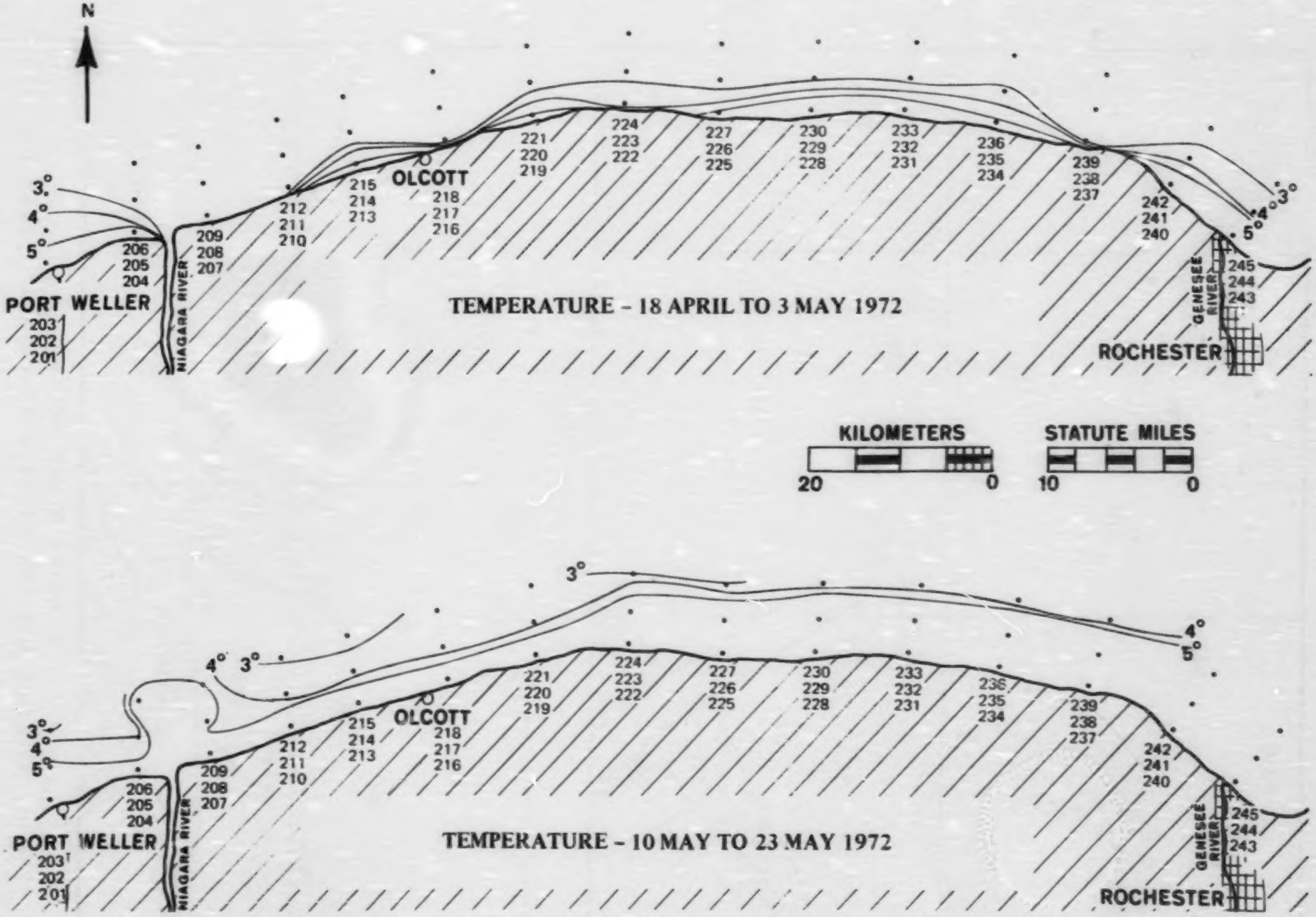
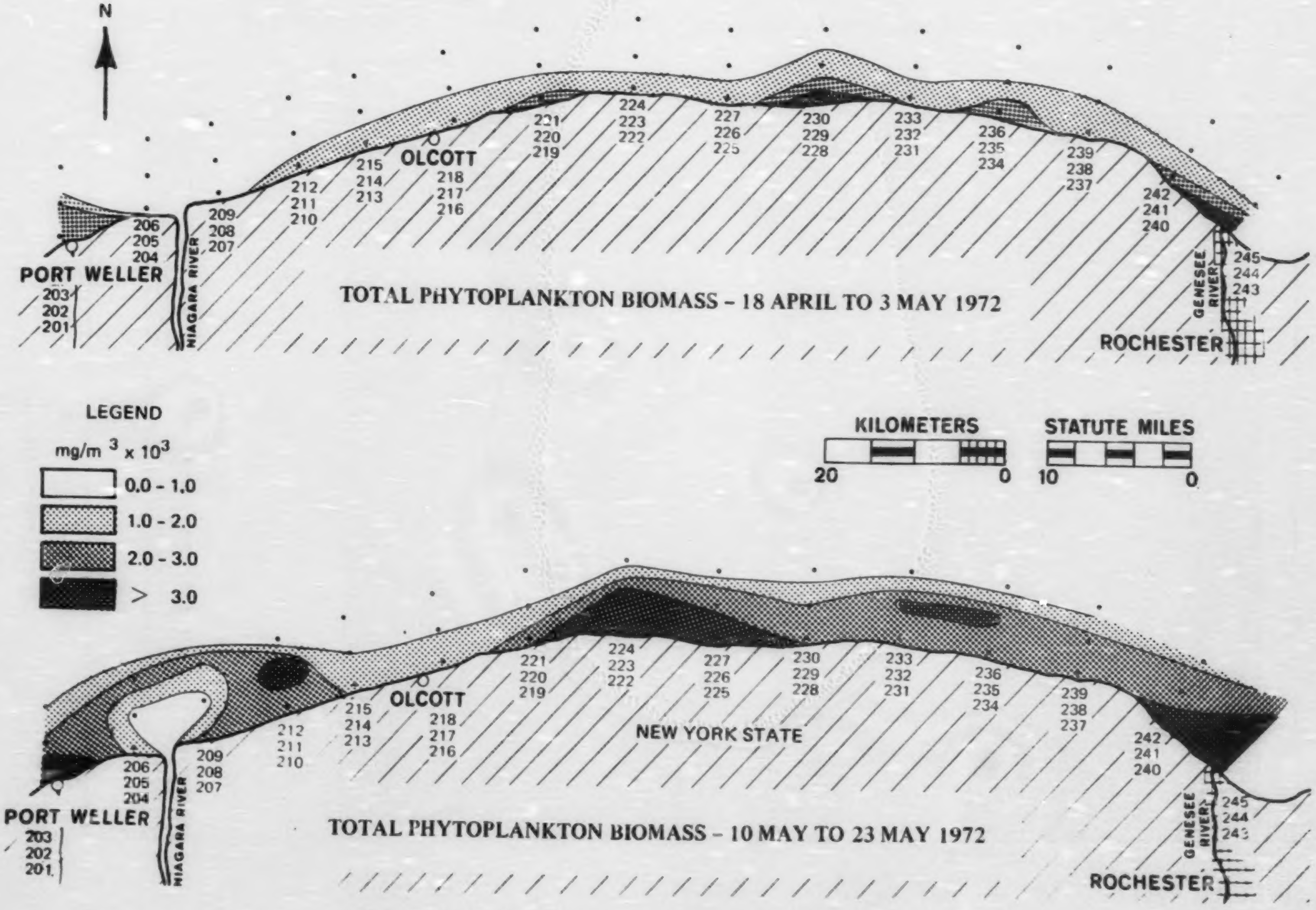

N
3°
4°
5°
PORT WELLER
203
202
201
206
205
204
NIAGARA RIVER
209
208
207
212
211
210
215
214
213
OLCOTT
218
217
216
221
220
219
224
223
222
227
226
225
230
229
228
233
232
231
236
235
234
239
238
237
242
241
240
GENESEE RIVER
245
244
243
ROCHESTER
TEMPERATURE - 18 APRIL TO 3 MAY 1972
KILOMETERS
20
0
STATUTE MILES
10
0
TEMPERATURE - 10 MAY TO 23 MAY 1972

Figure 4. Horizontal thermal stratification during spring 1972



N
PORT WELLER
NIAGARA RIVER
OLCOTT
ROCHESTER
GENESEE RIVER
NEW YORK STATE
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
LEGEND
mg/m 3 x 10³
0.0 - 1.0
1.0 - 2.0
2.0 - 3.0
> 3.0
KILOMETERS
20
0
STATUTE MILES
10
0

TOTAL PHYTOPLANKTON BIOMASS – 18 APRIL TO 3 MAY 1972

TOTAL PHYTOPLANKTON BIOMASS – 10 MAY TO 23 MAY 1972

Figure 5. Phytoplankton biomass for April-May 1972

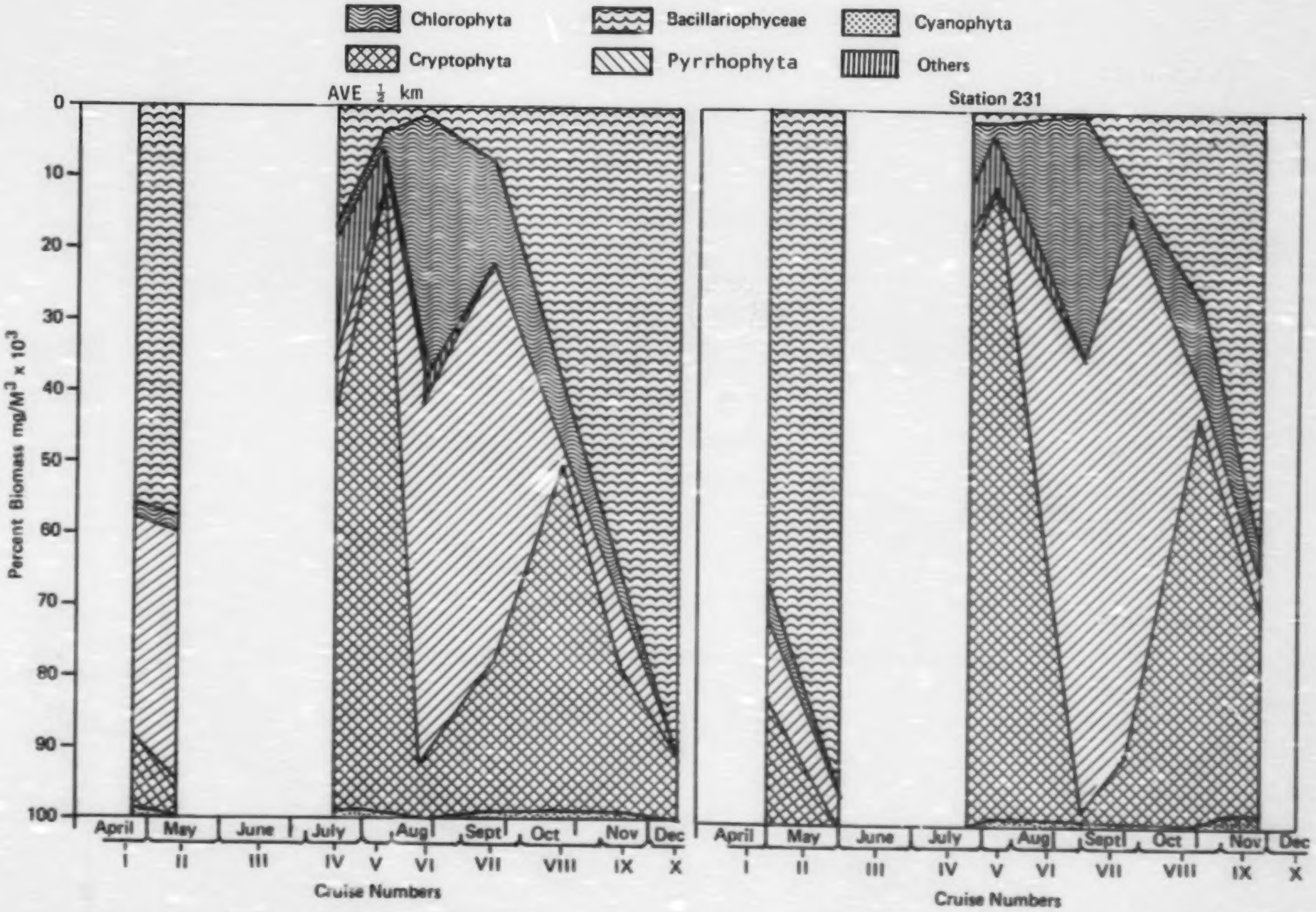


Figure 6. Average percent composition and percent composition for station 231 and stations 1/2 kilometer from shore

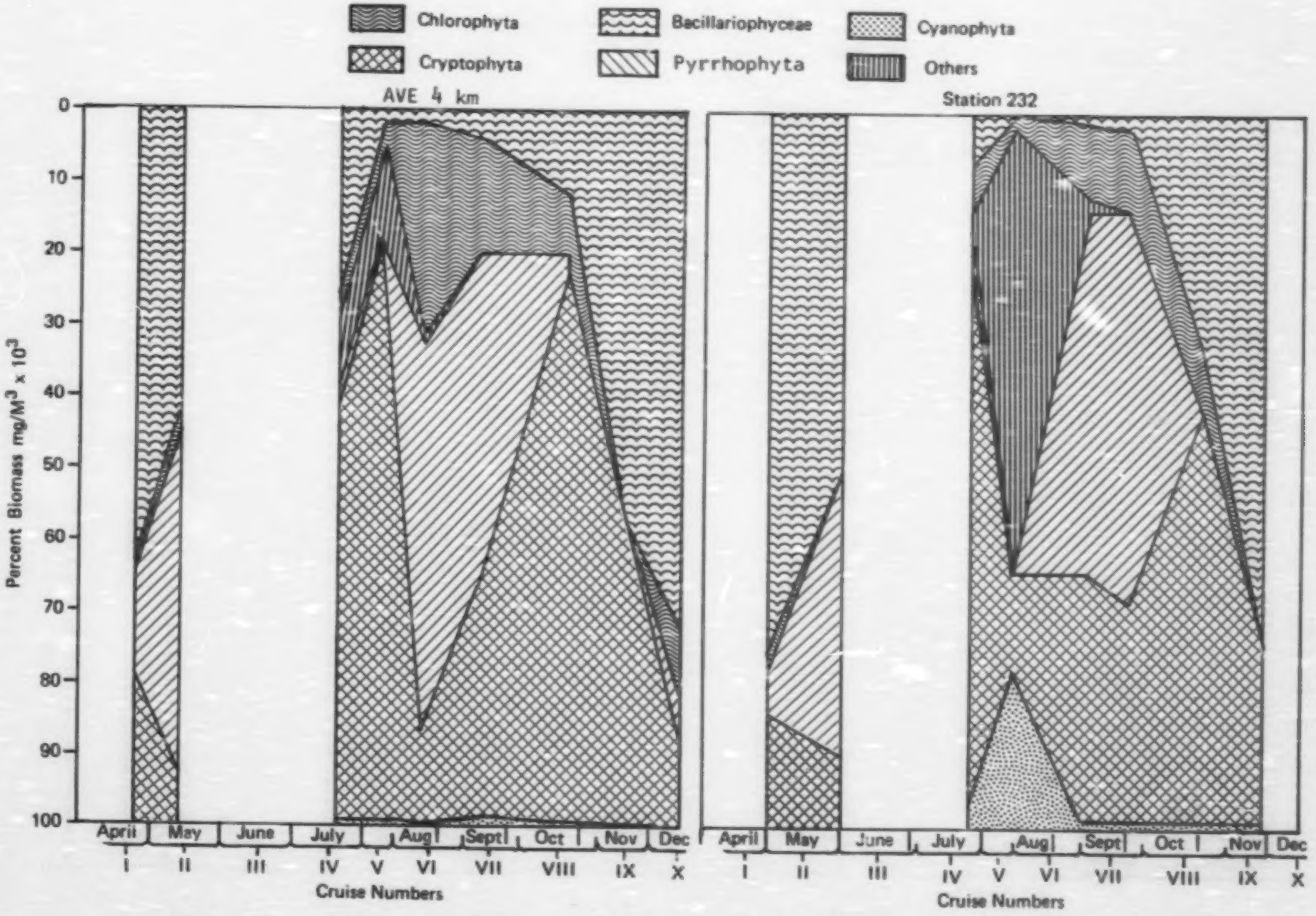


Figure 7. Average percent composition and percent composition for station 232 and stations 4 kilometers from shore

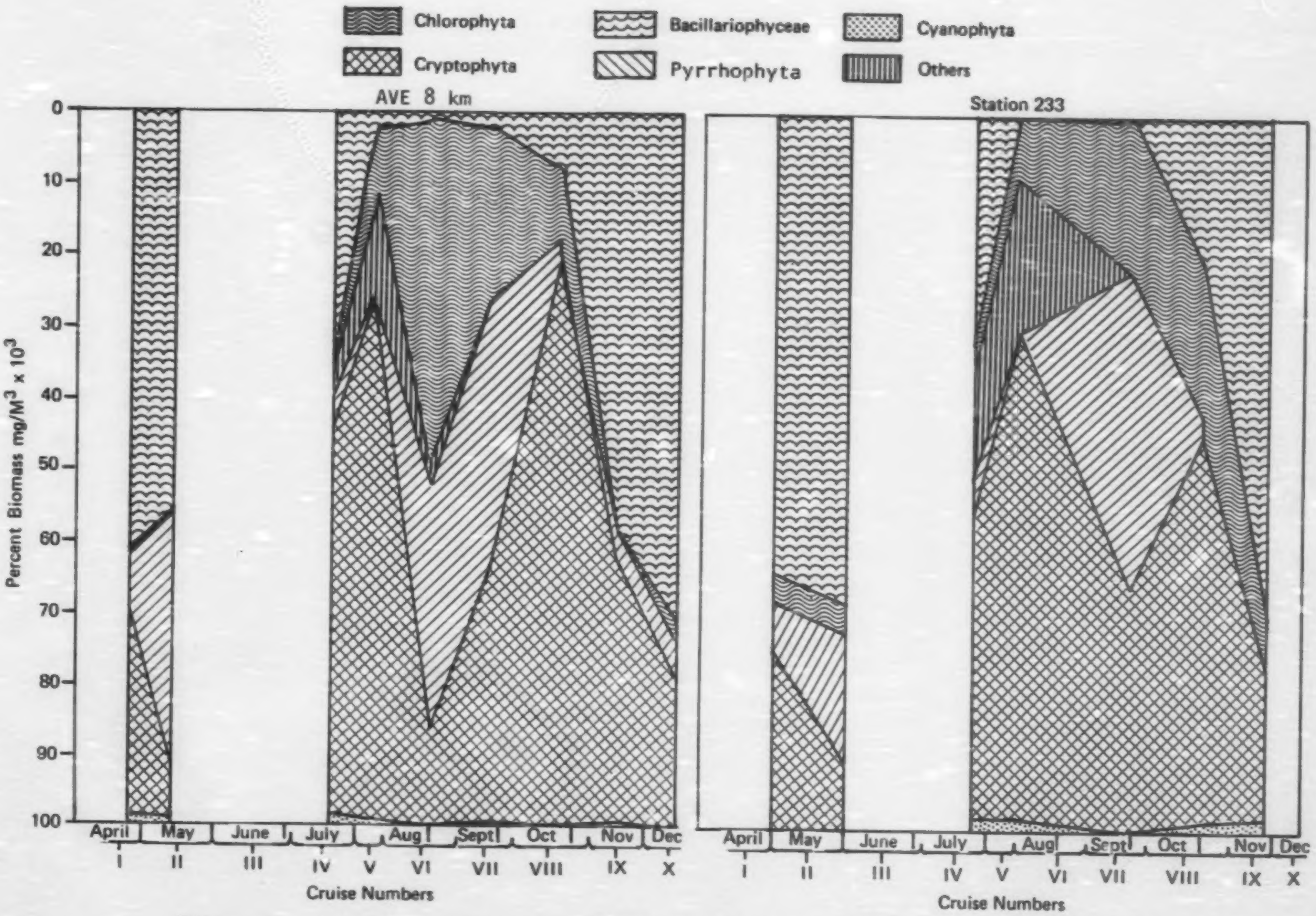


Figure 8. Average percent composition and percent composition for station 233 and stations 8 kilometers from shore

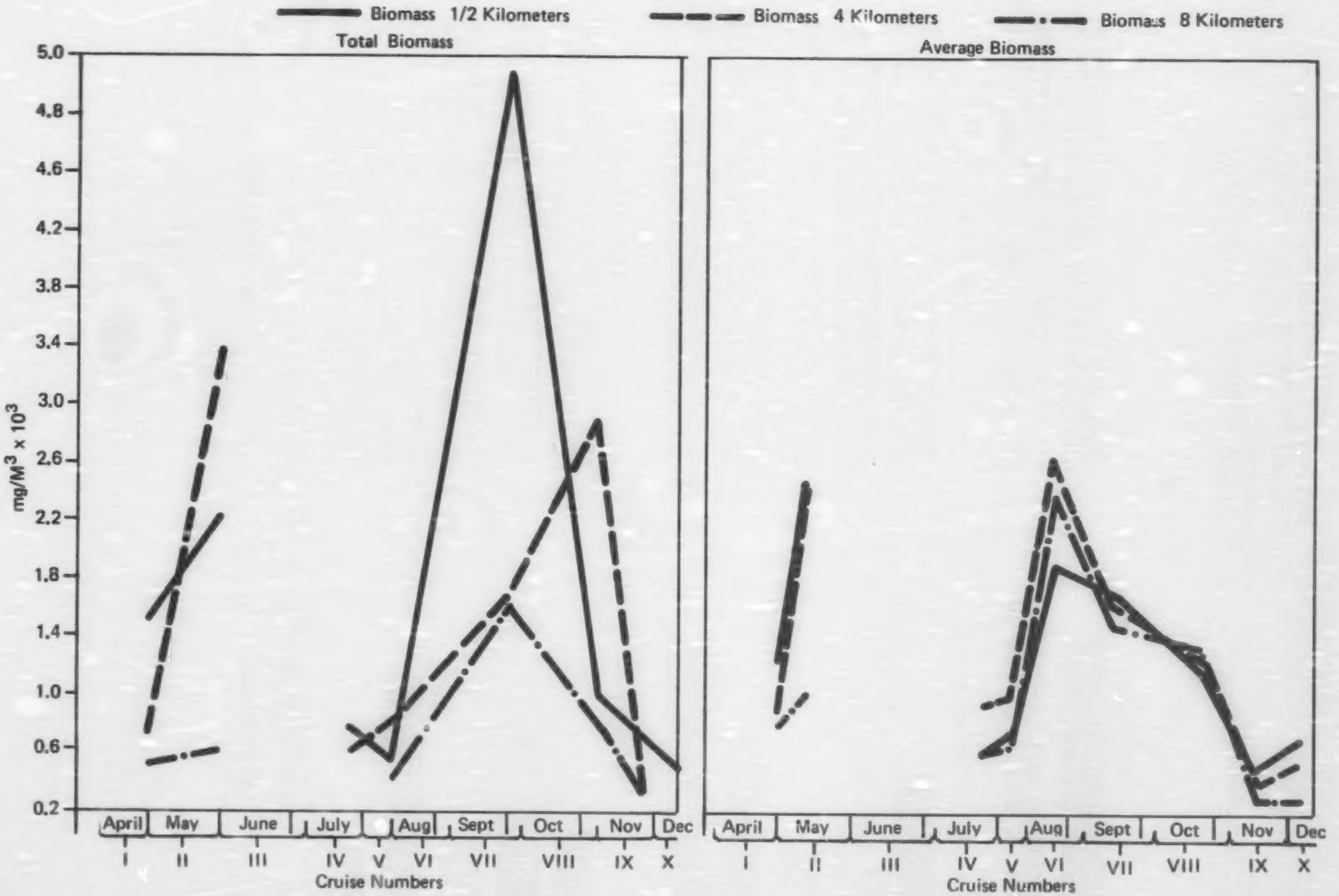


Figure 9. Total biomass at Stations 231, 232, and 233, and average biomass for all stations at 1/2, 4 and 8 kilometers

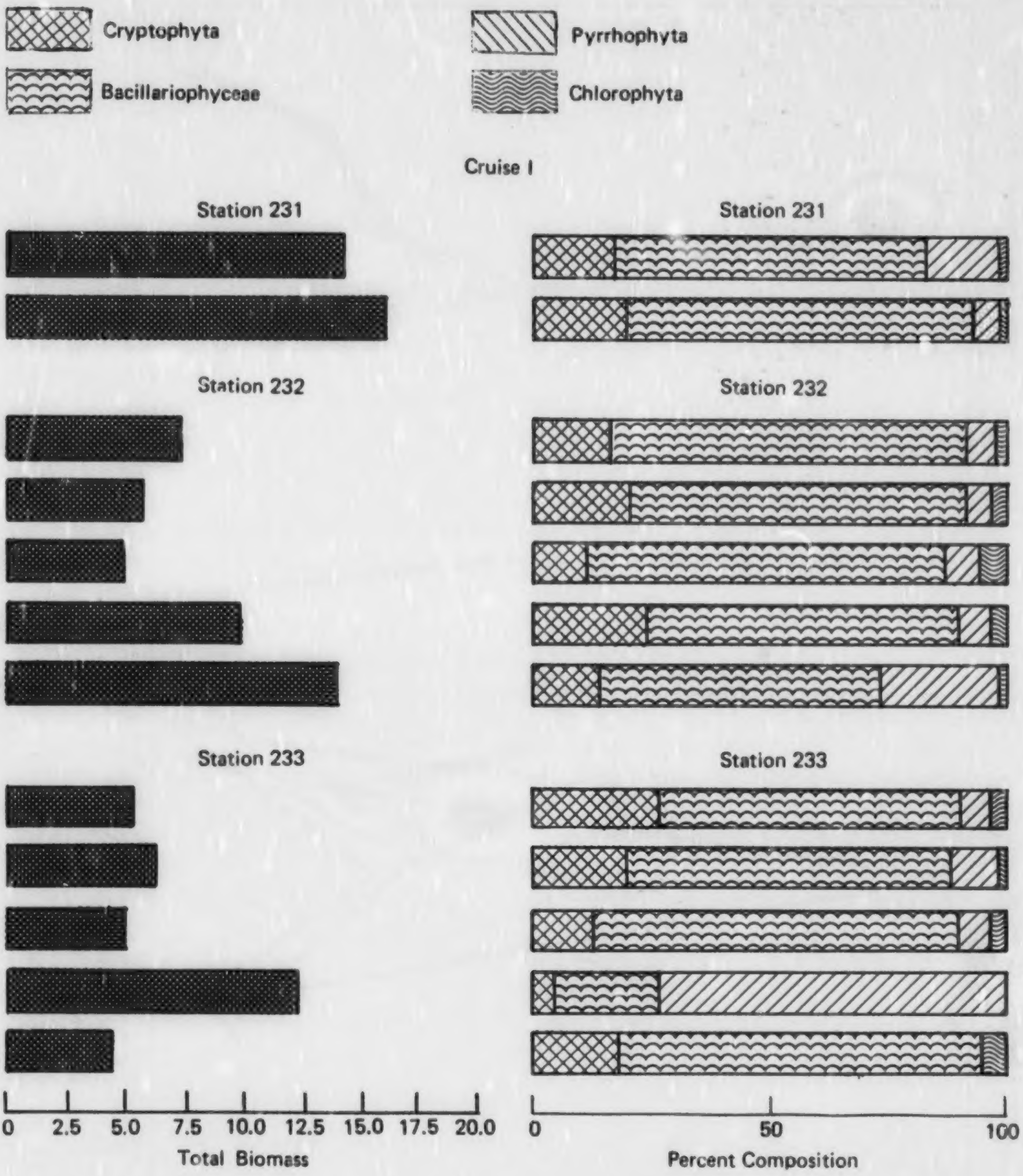


Figure 10. Vertical biomass and percent composition, cruise I

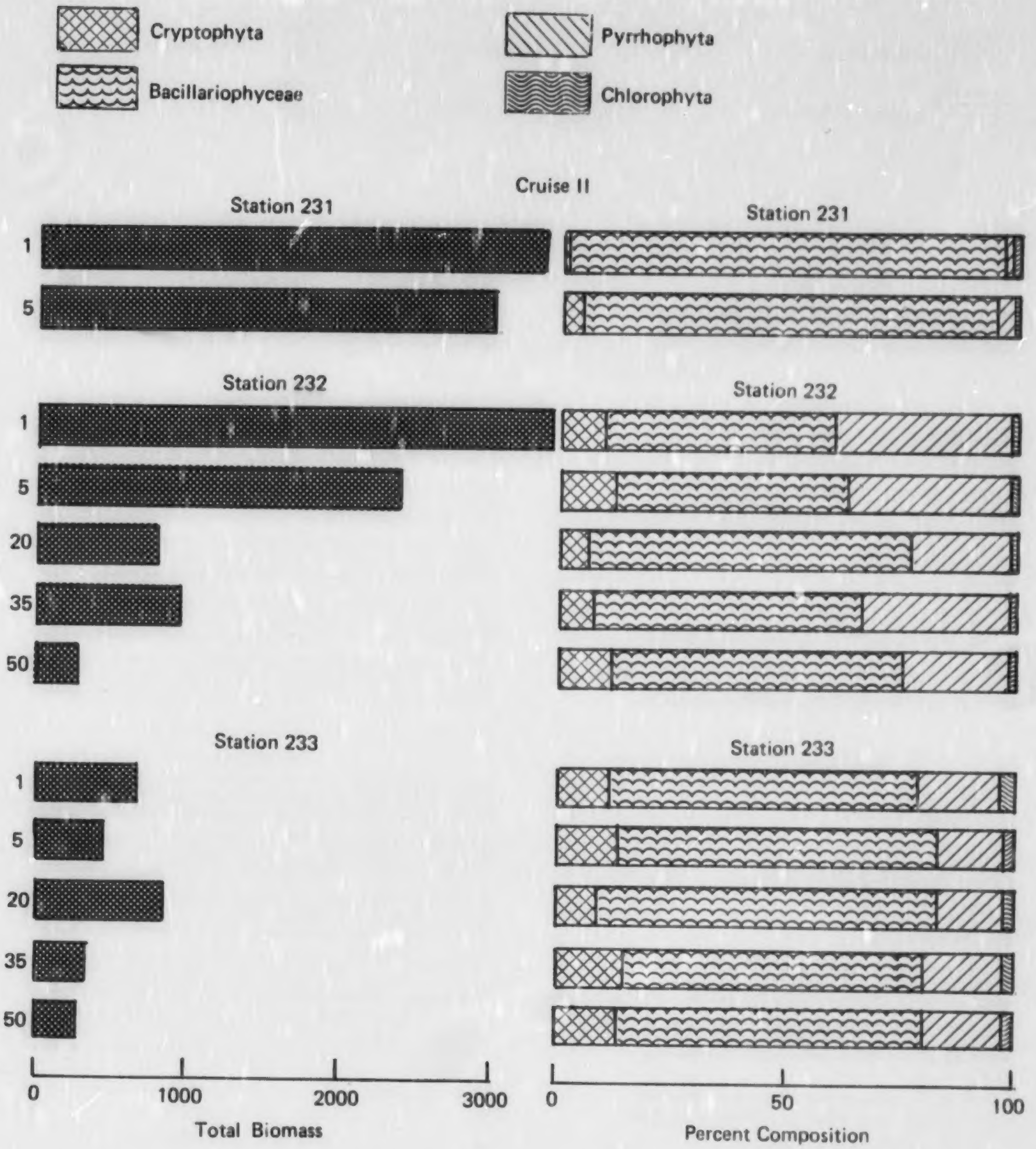


Figure 11. Vertical biomass and percent composition, cruise II

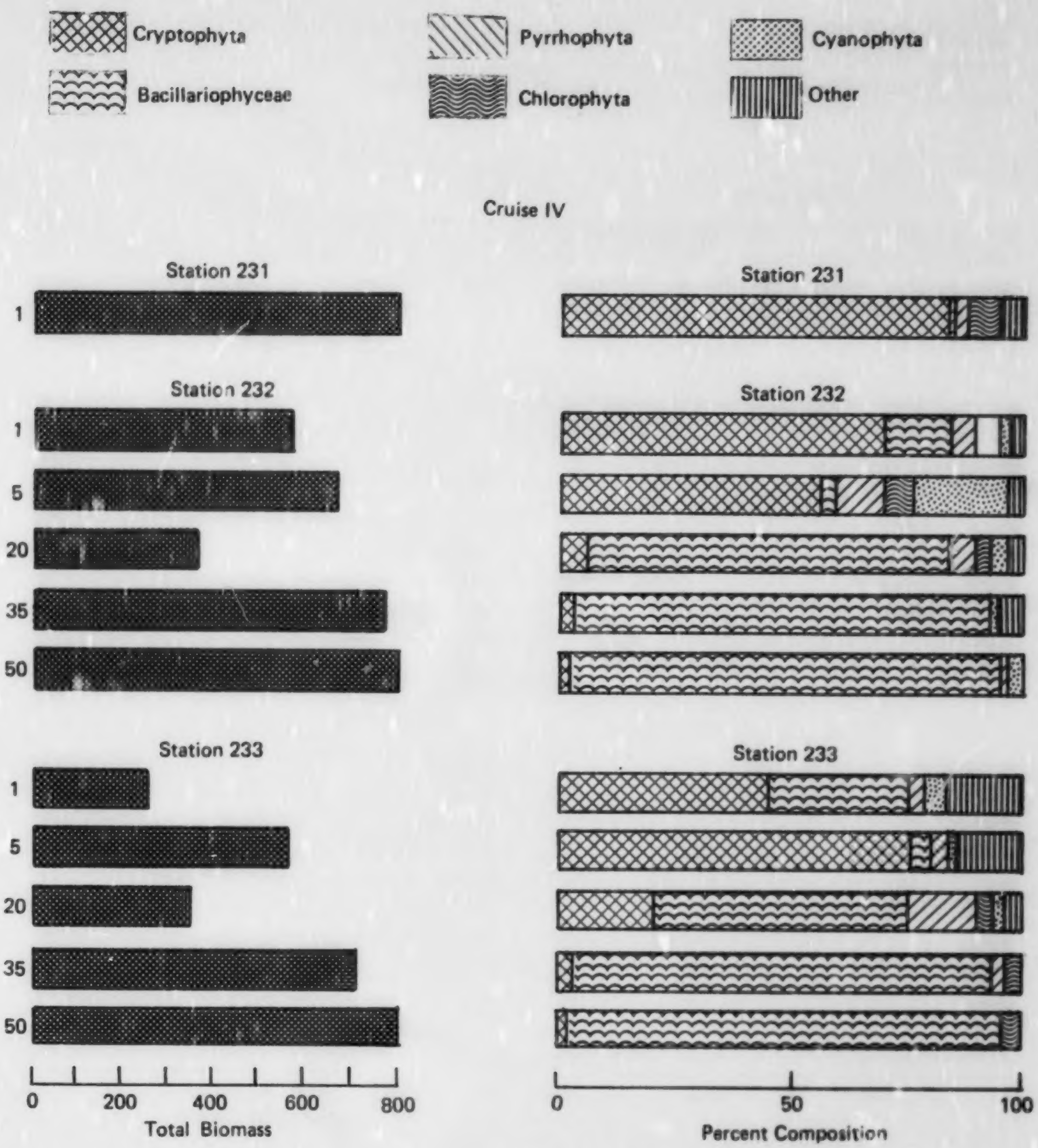


Figure 12. Vertical biomass and percent composition, cruise IV

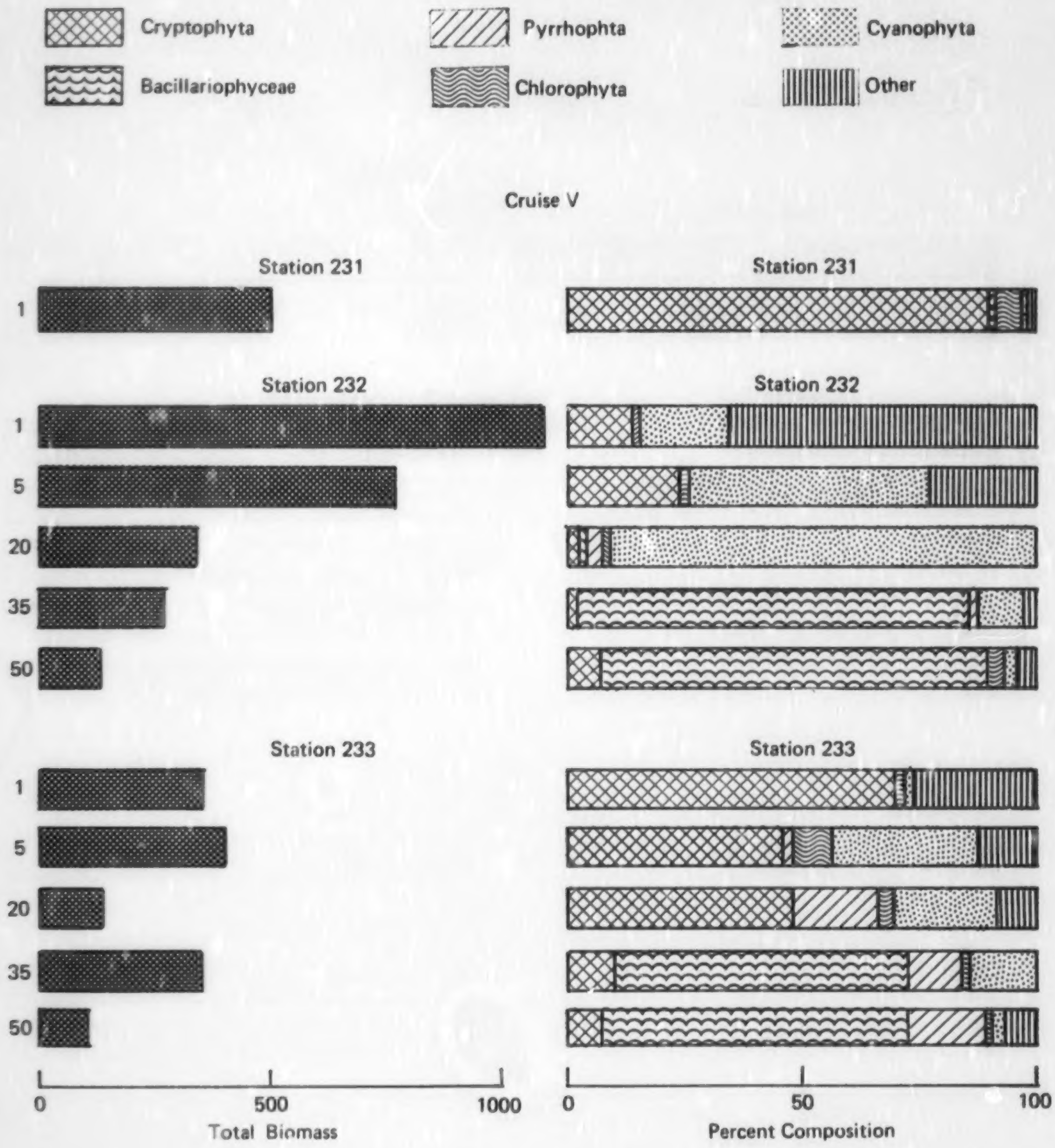


Figure 13. Vertical biomass and percent composition, cruise V

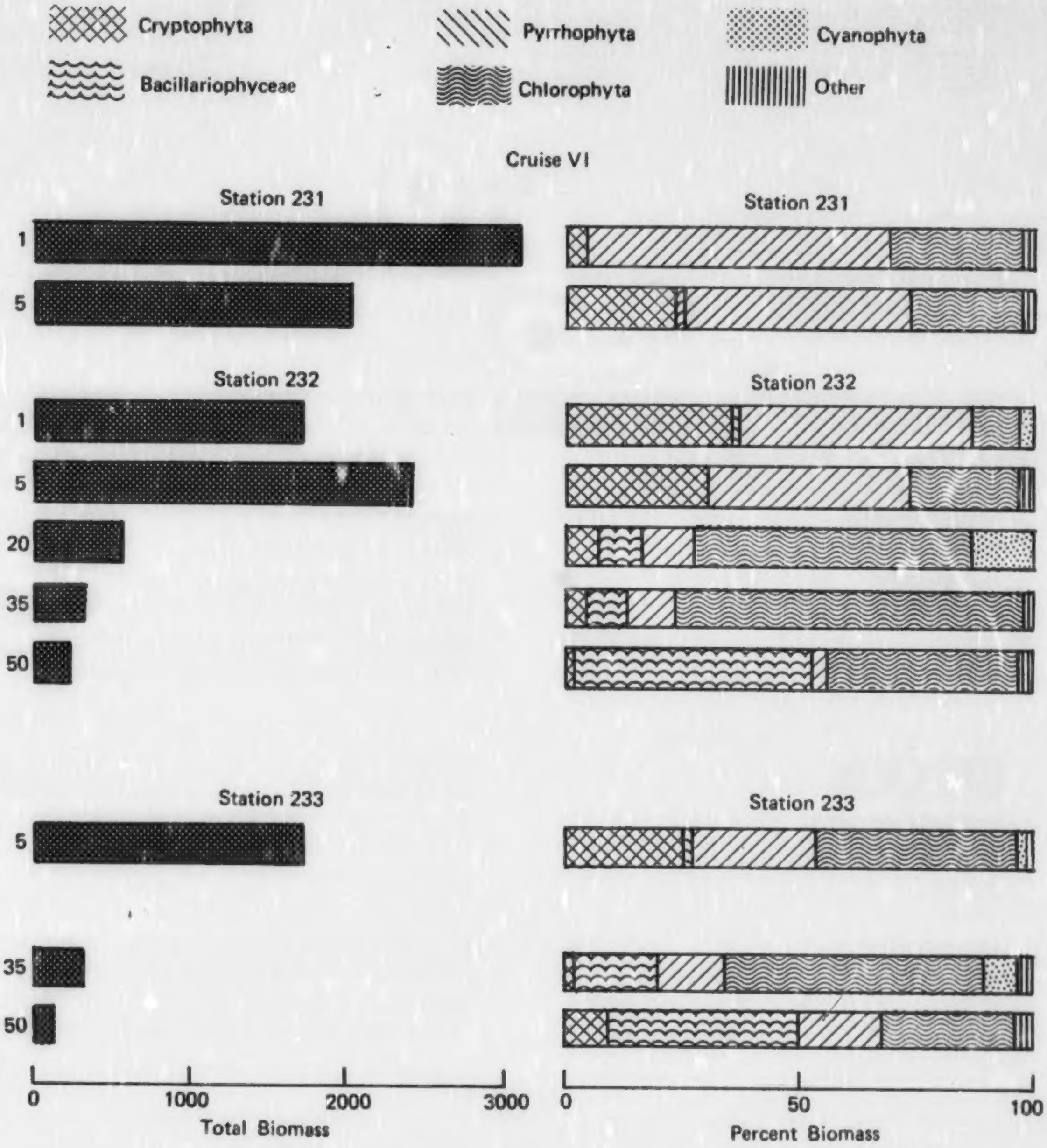


Figure 14. Vertical biomass and percent composition, cruise VI

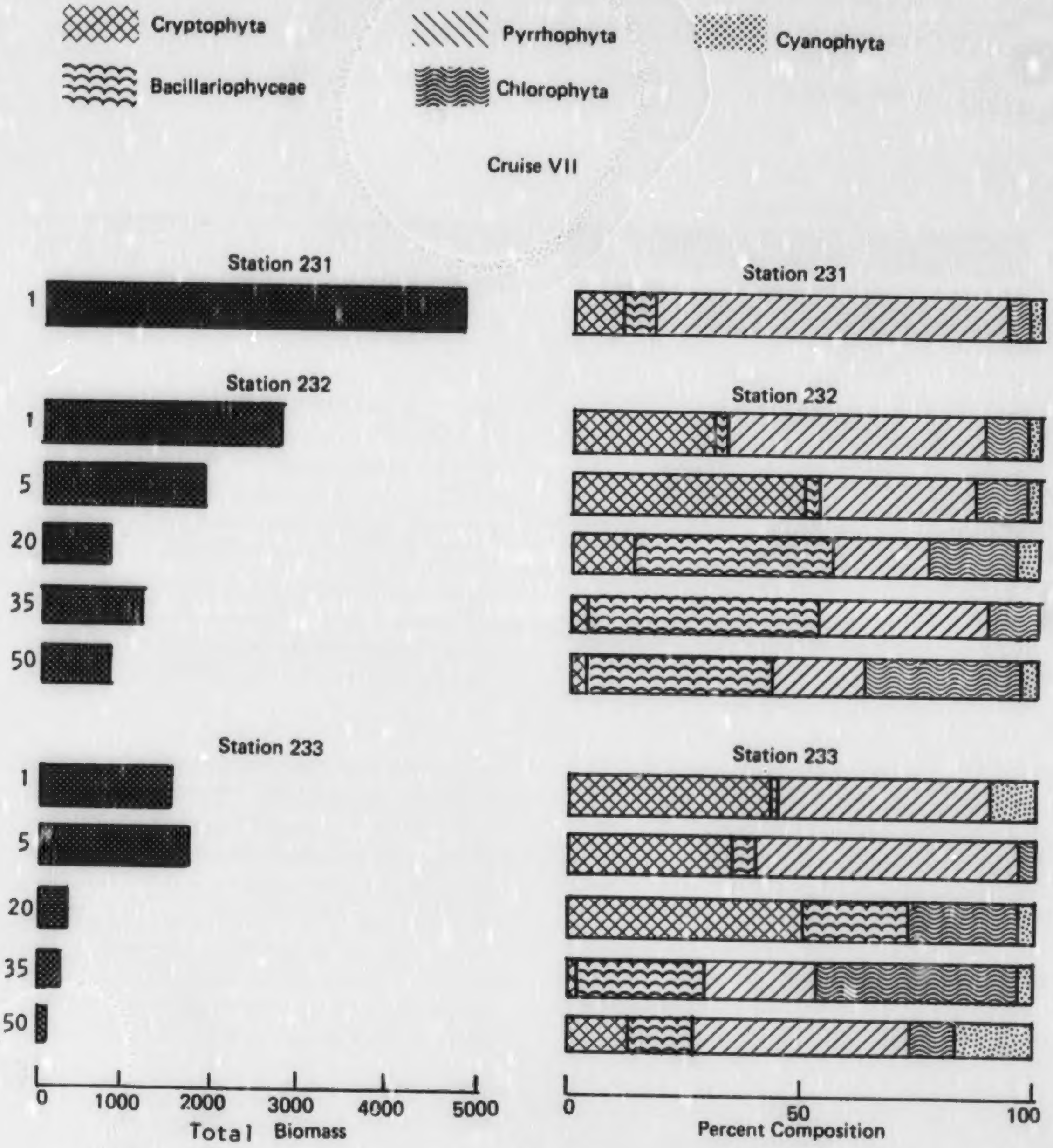


Figure 15. Vertical biomass and percent composition, cruise VII

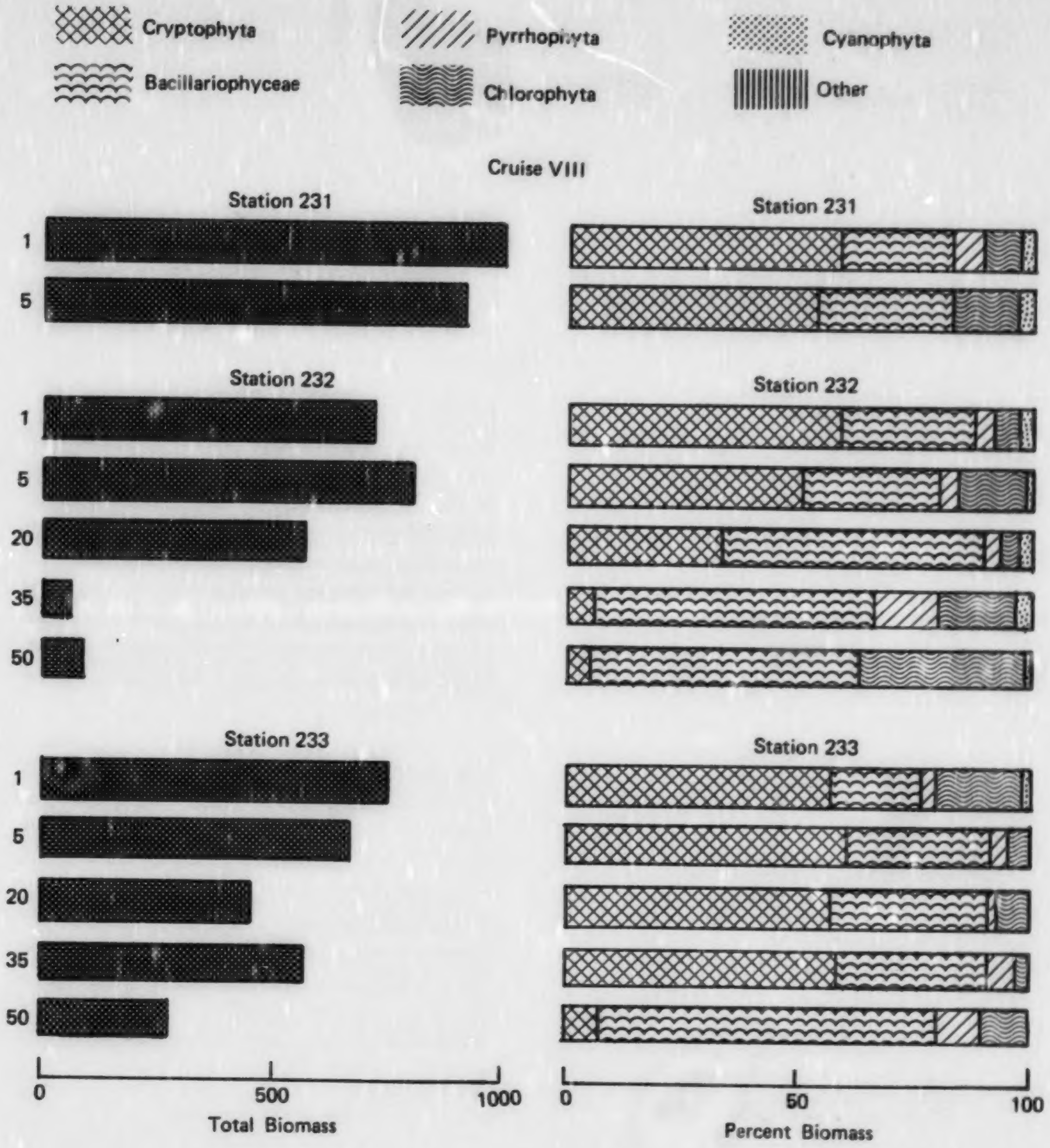


Figure 16. Vertical biomass and percent composition, cruise VIII

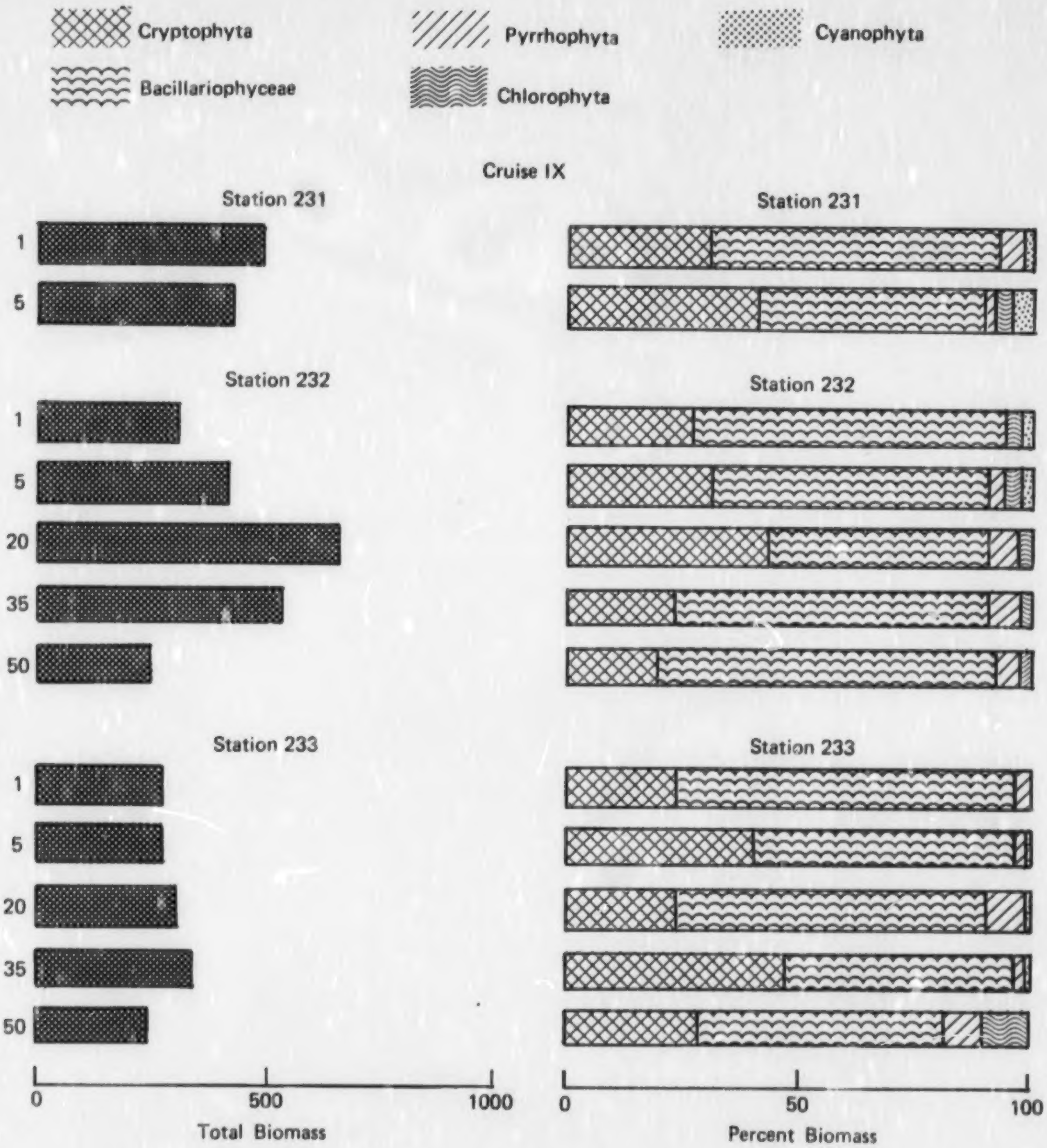


Figure 17. Vertical biomass and percent composition, cruise IX

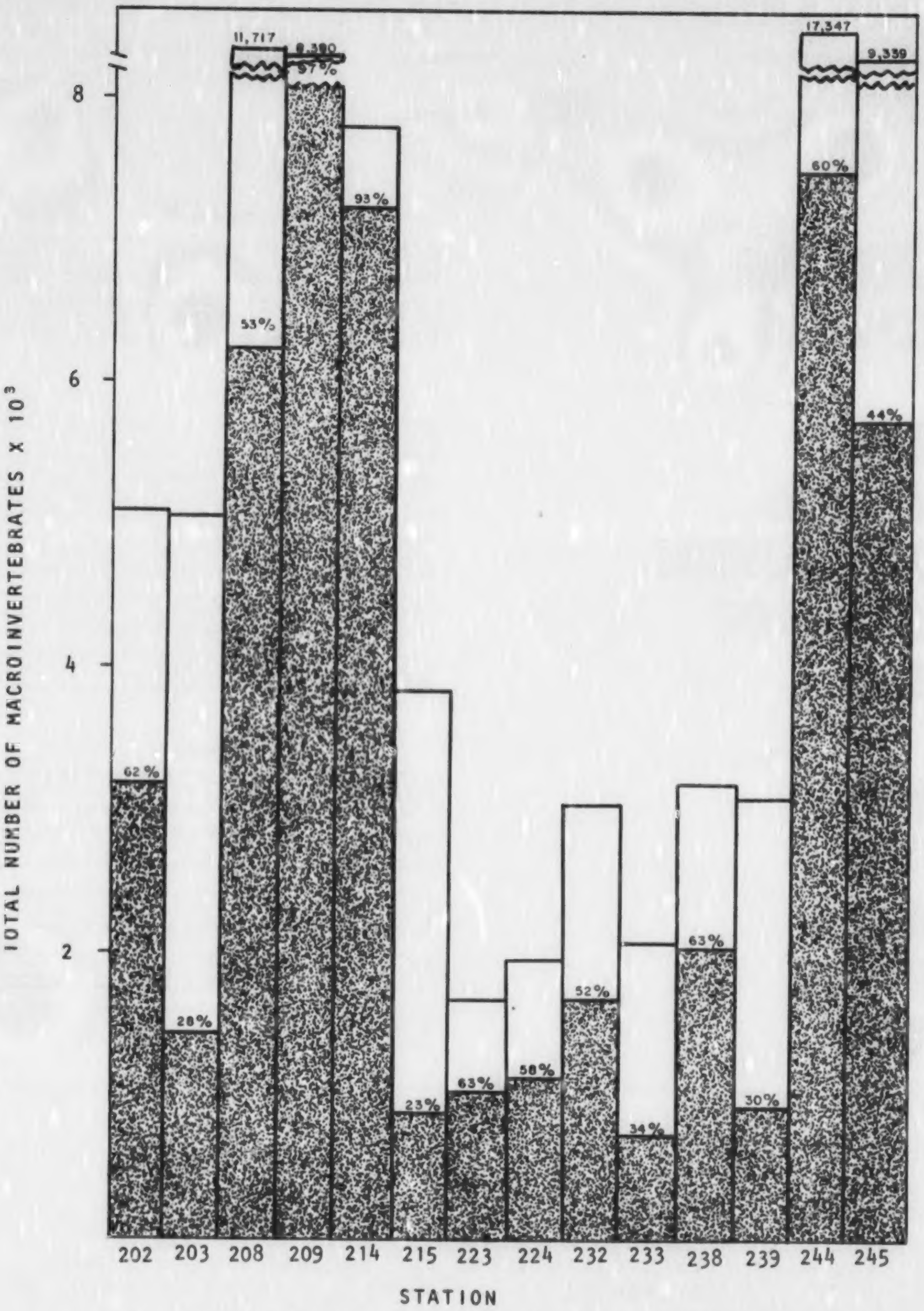


Figure 18. Percent total Oligochaeta to total macroinvertebrates encountered during 1972-1973

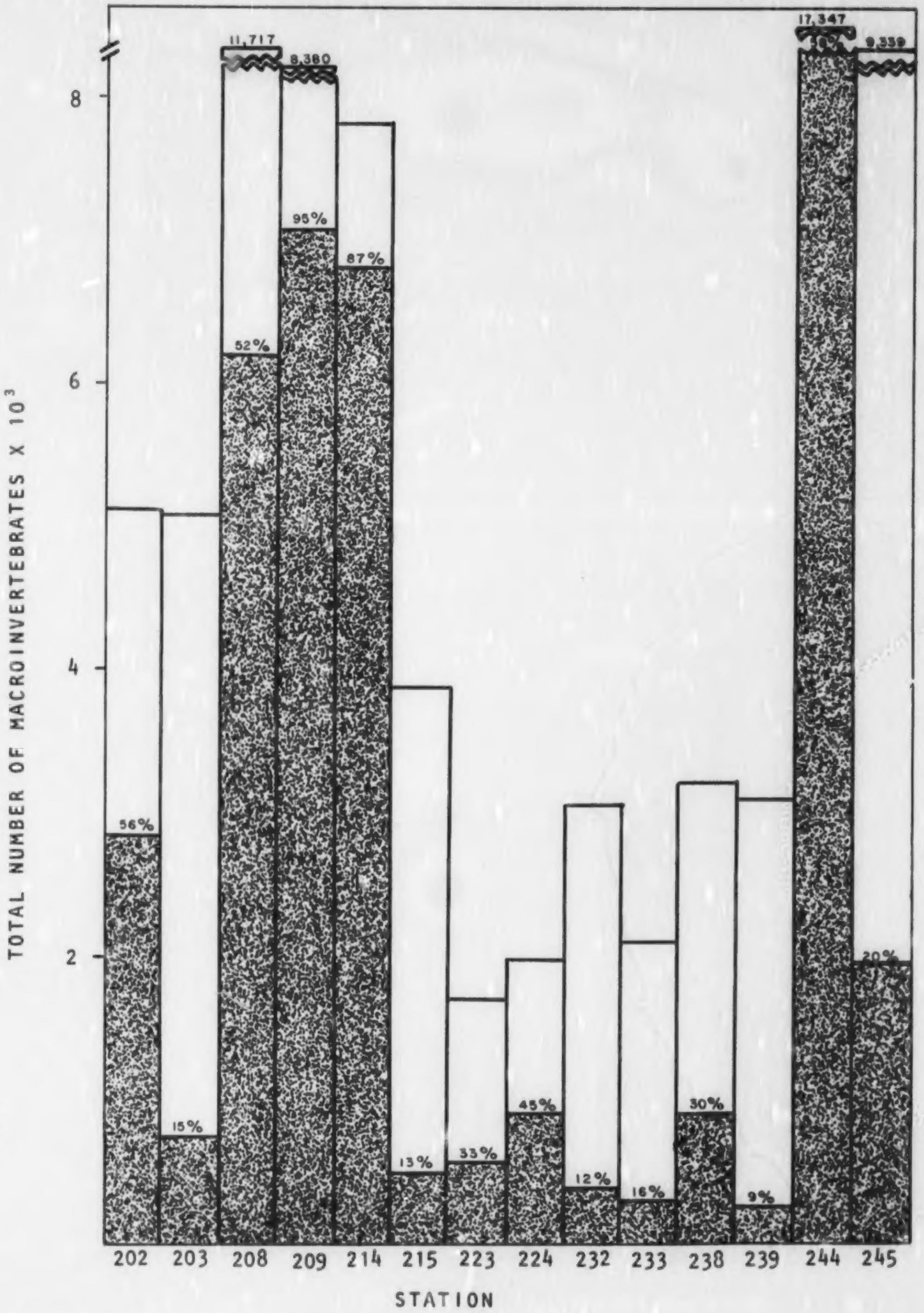


Figure 19. Percent Tubificidae to total macroinvertebrates encountered during 1972-1973

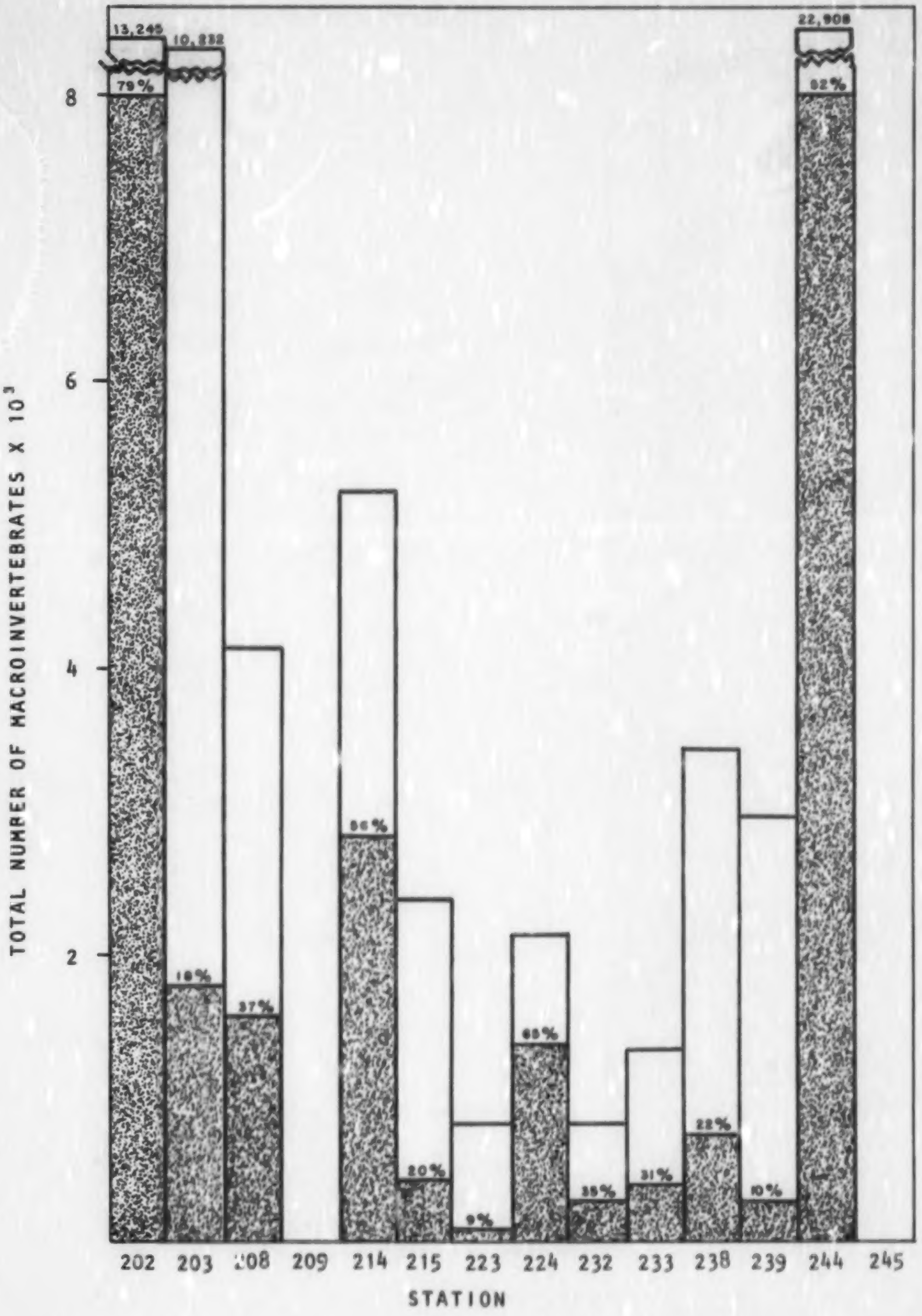


Figure 20. Percent Tubificidae to total macroinvertebrates encountered during cruise I

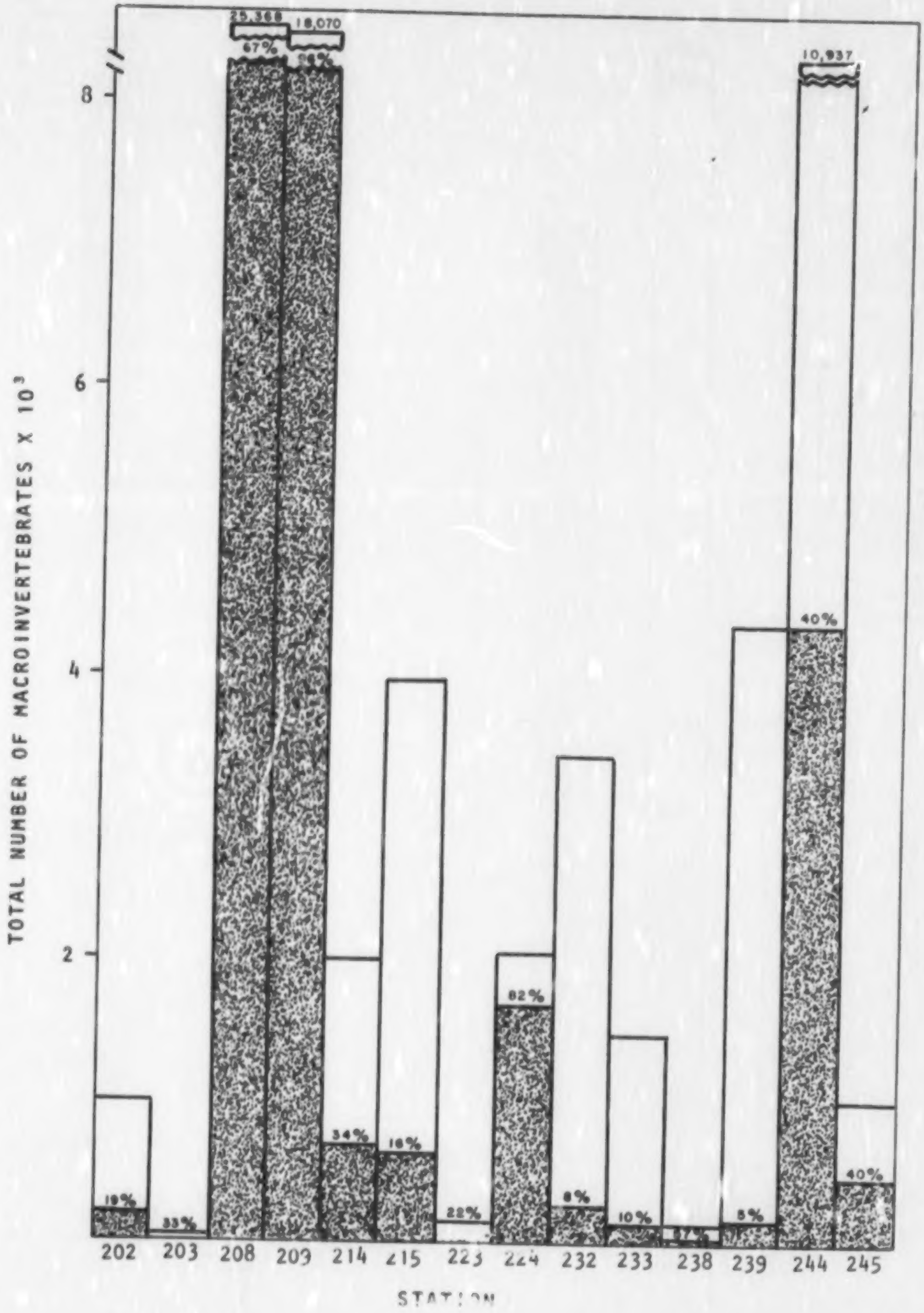


Figure 21. Percent Tubificidae to total macroinvertebrates encountered during cruise III

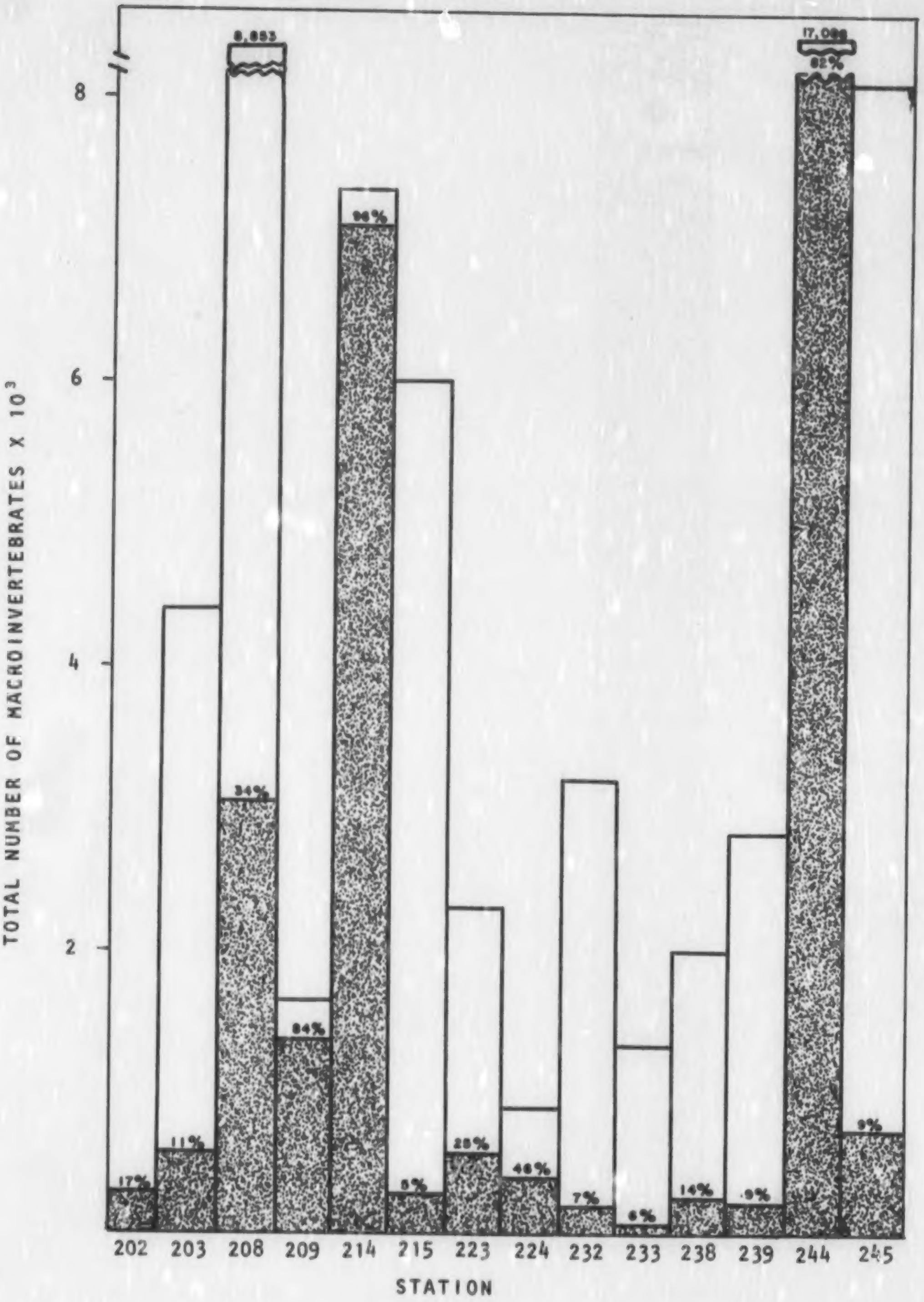


Figure 22. Percent tubificidae to total macroinvertebrates encountered during cruise VI

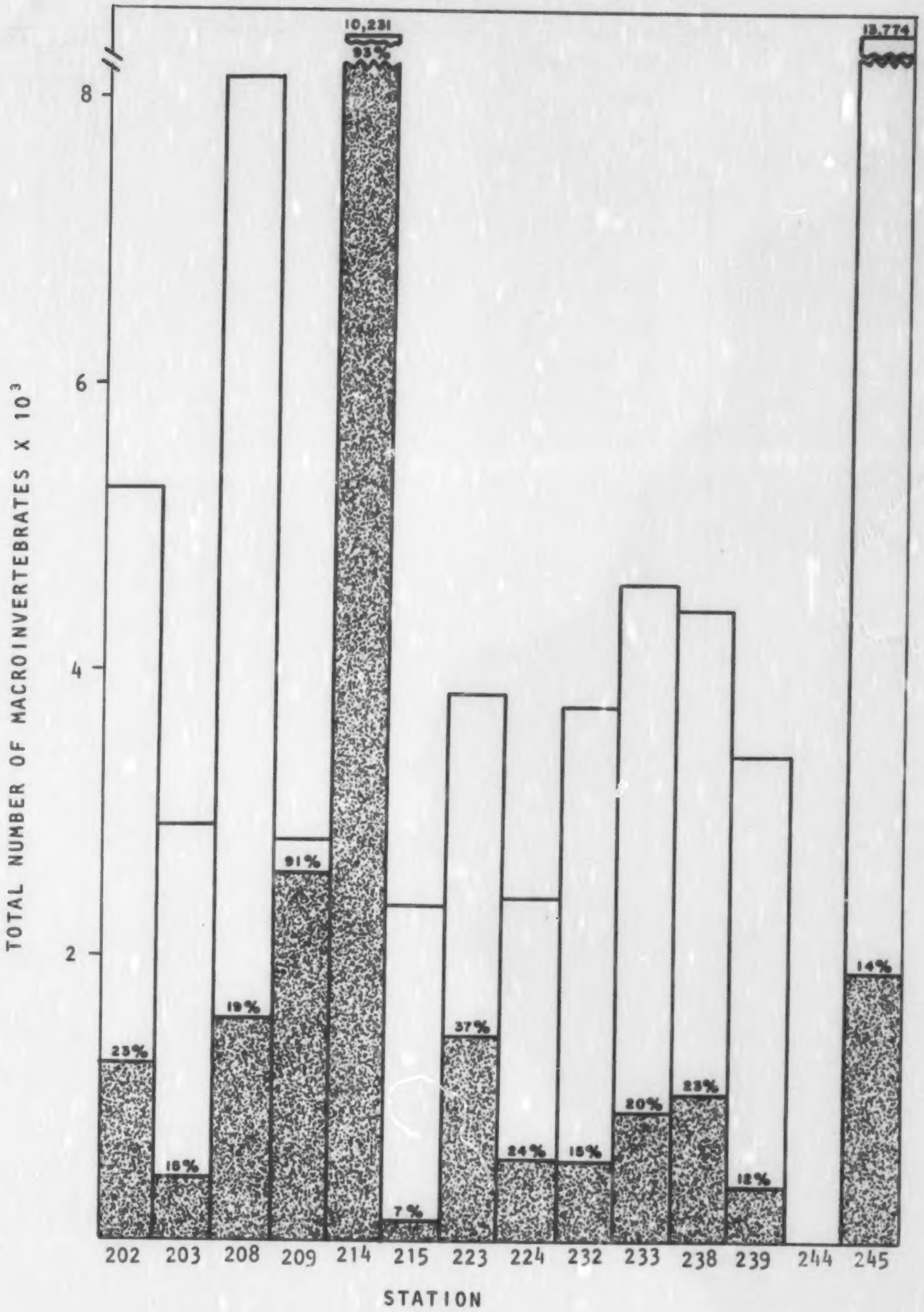


Figure 23. Percent Tubificidae to total macroinvertebrates encountered during cruise IX

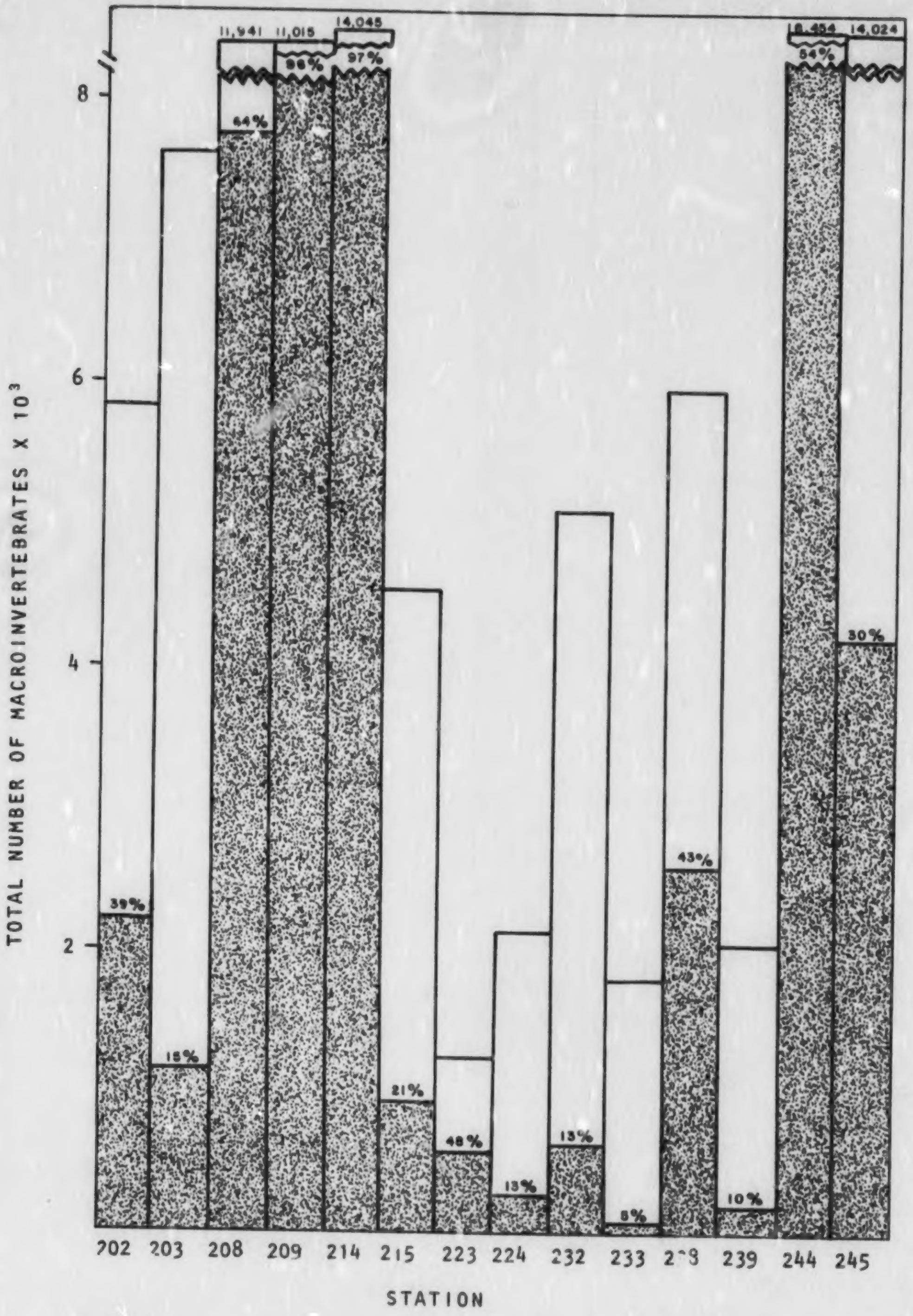


Figure 24. Percent Tubificidae to total macroinvertebrates encountered during cruise XI

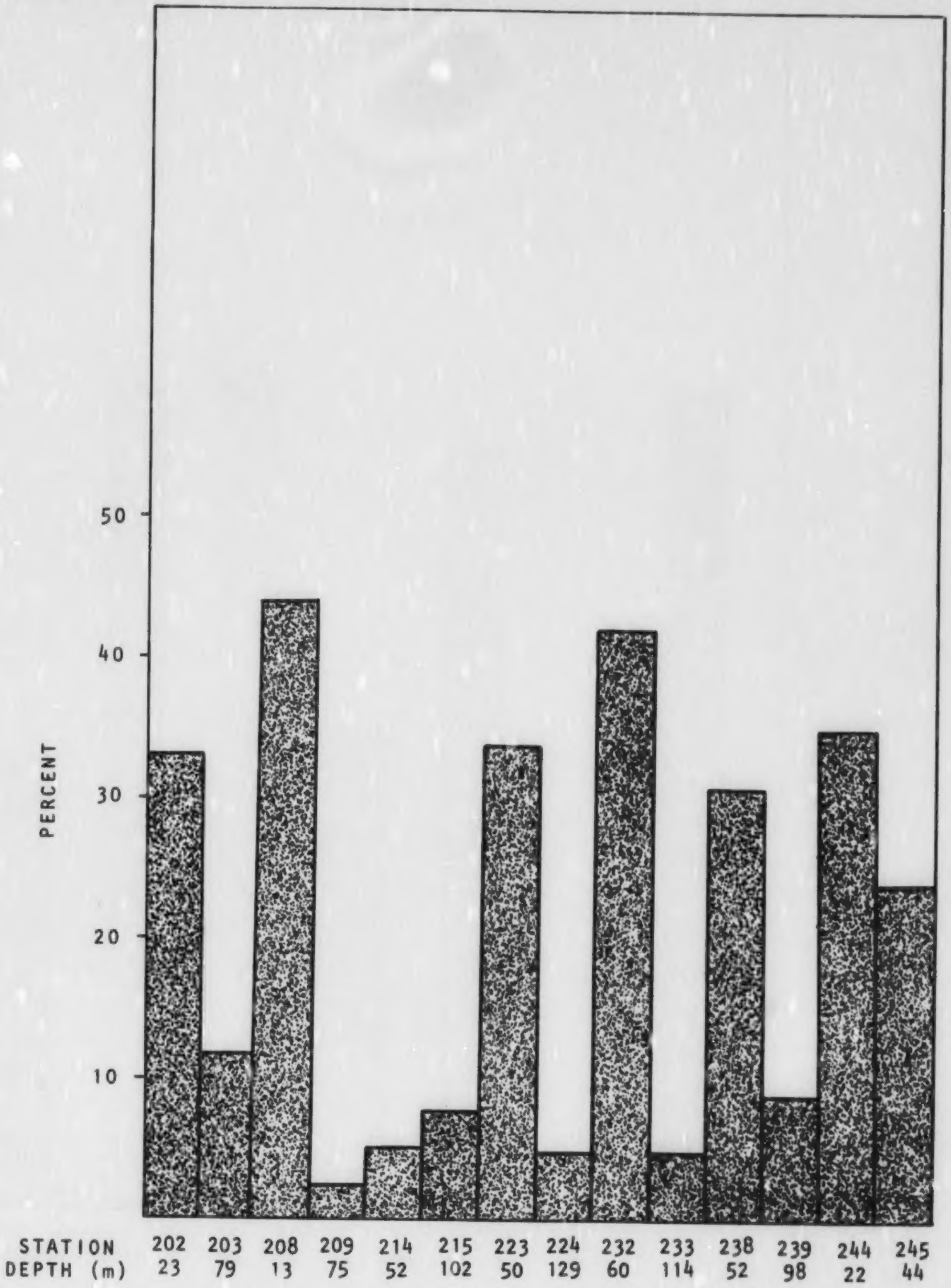


Figure 25. Percent Sphaeriidae of total macroinvertebrates encountered during 1972-1973

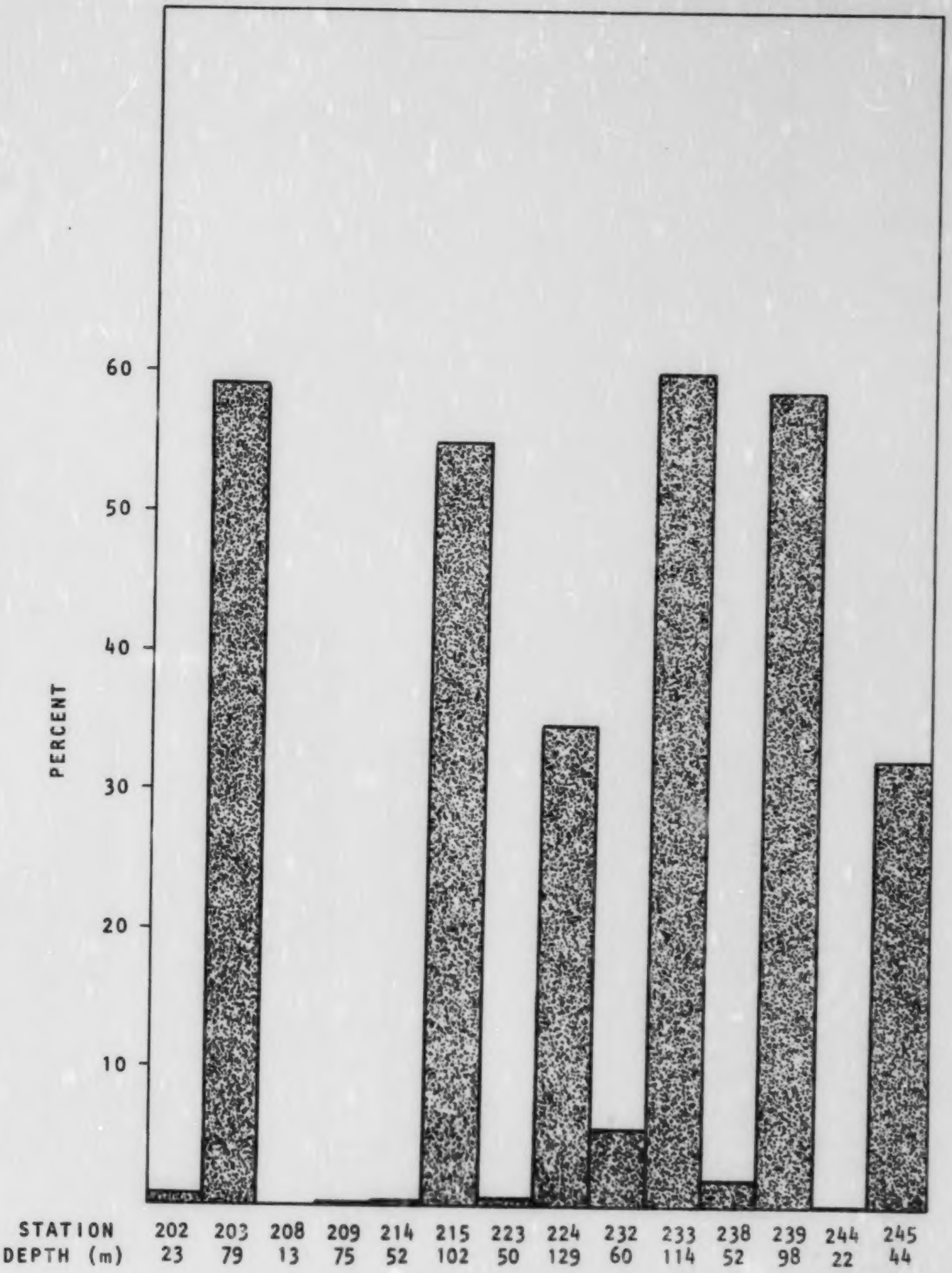


Figure 26. Percent *Pontoporeia affinis* of total macroinvertebrates encountered during 1972-193

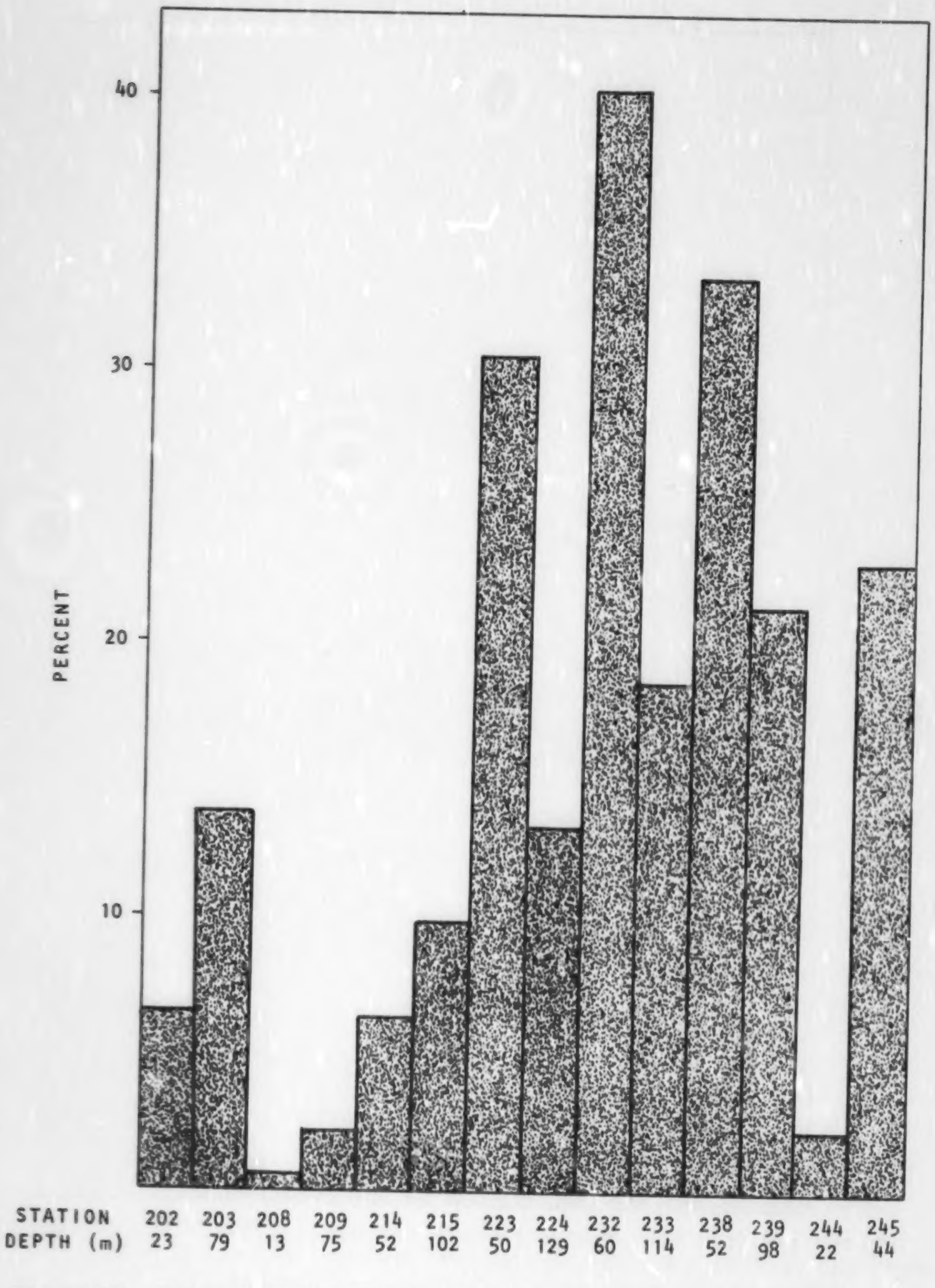


Figure 27. Percent Stylodrilus heringianus of total macroinvertebrates encountered during 1972-1973

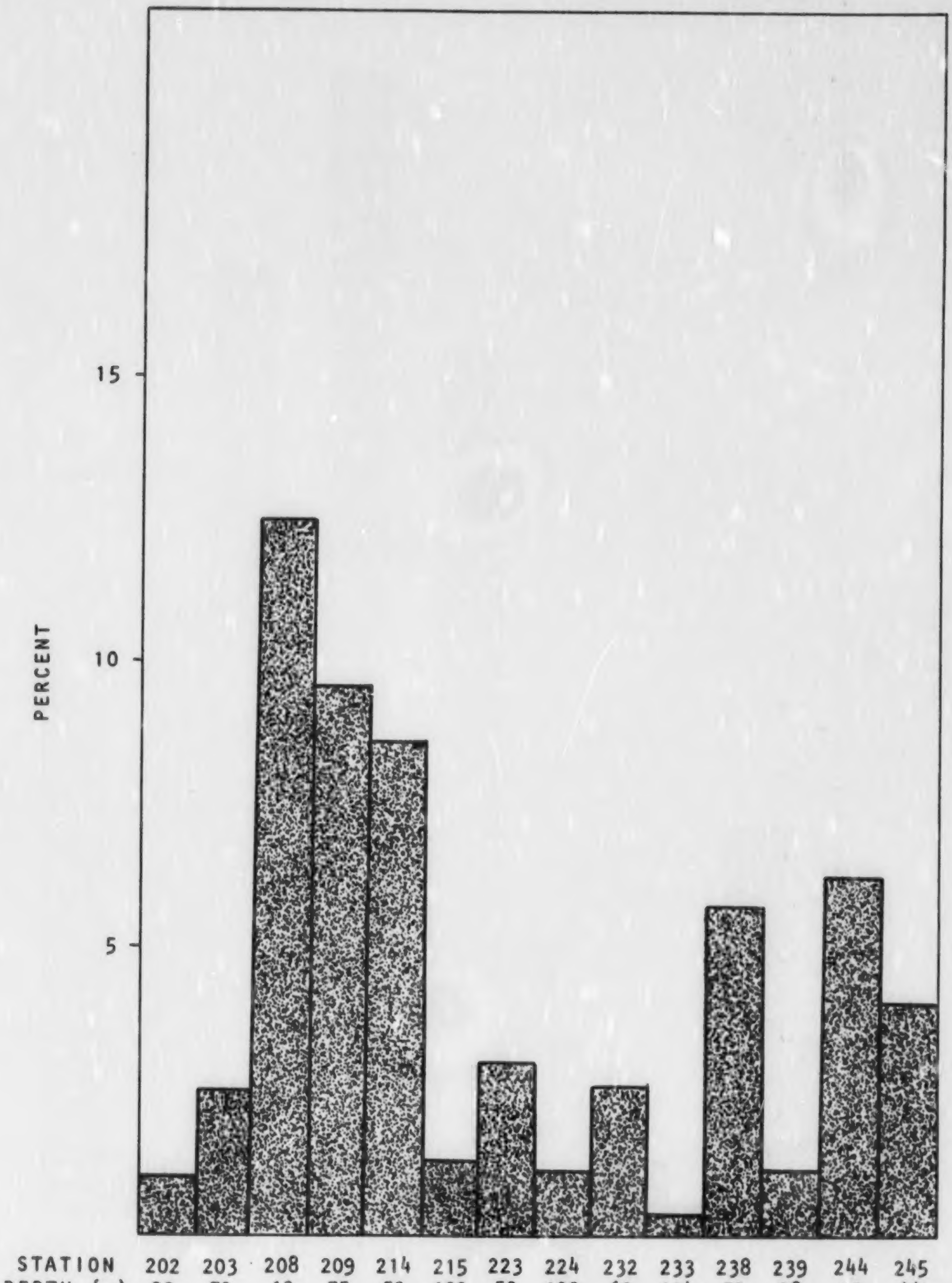


Figure 28. Percent Limnodrilus hoffmeisteri of total macroinvertebrates encountered during 1972-1973

Figure 29. Sediment phosphorus content nearshore zone
Southwestern Lake Ontario cruise I
18 April-3 May 1972

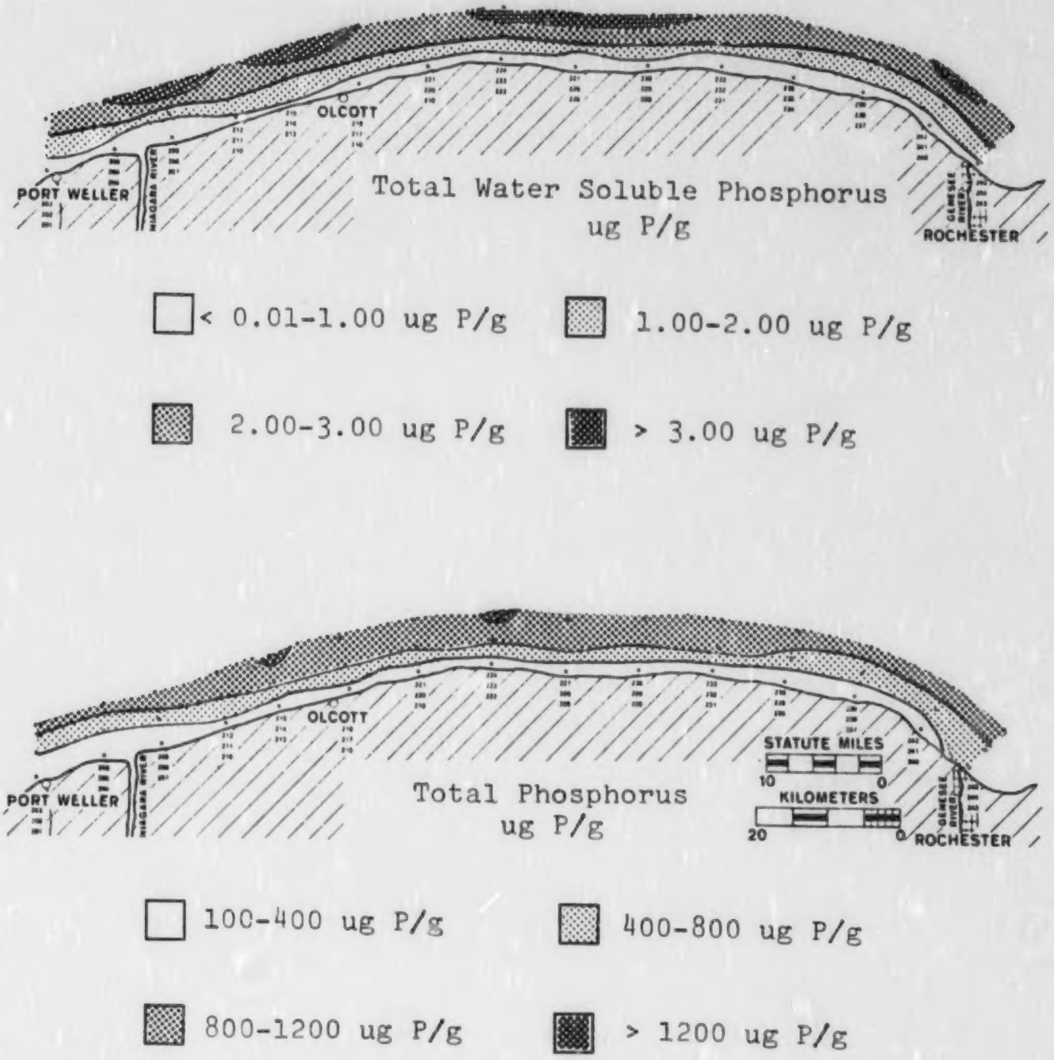
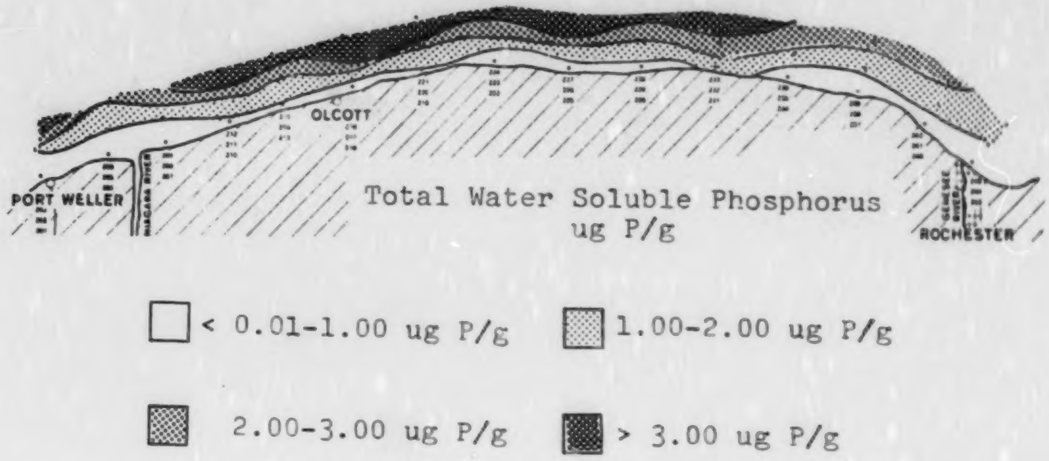

OLCOTT
PORT WELLER
NIAGARA RIVER
GENESEE RIVER
ROCHESTER
Total Water Soluble Phosphorus
ug P/g
< 0.01-1.00 ug P/g
1.00-2.00 ug P/g
2.00-3.00 ug P/g
> 3.00 ug P/g
OLCOTT
STATUTE MILES
10
0
KILOMETERS
20
0
PORT WELLER
NIAGARA RIVER
GENESEE RIVER
ROCHESTER
Total Phosphorus
ug P/g
100-400 ug P/g
400-800 ug P/g
800-1200 ug P/g
> 1200 ug P/g

Figure 30. Sediment phosphorus content nearshore zone
Southwestern Lake Ontario cruise III
19-28 June 1972


PORT WELLER
NIAGARA RIVER
OLCOTT
GENESEE RIVER
ROCHESTER
Total Water Soluble Phosphorus
ug P/g
☐ < 0.01-1.00 ug P/g
▨ 1.00-2.00 ug P/g
▨ 2.00-3.00 ug P/g
■ > 3.00 ug P/g

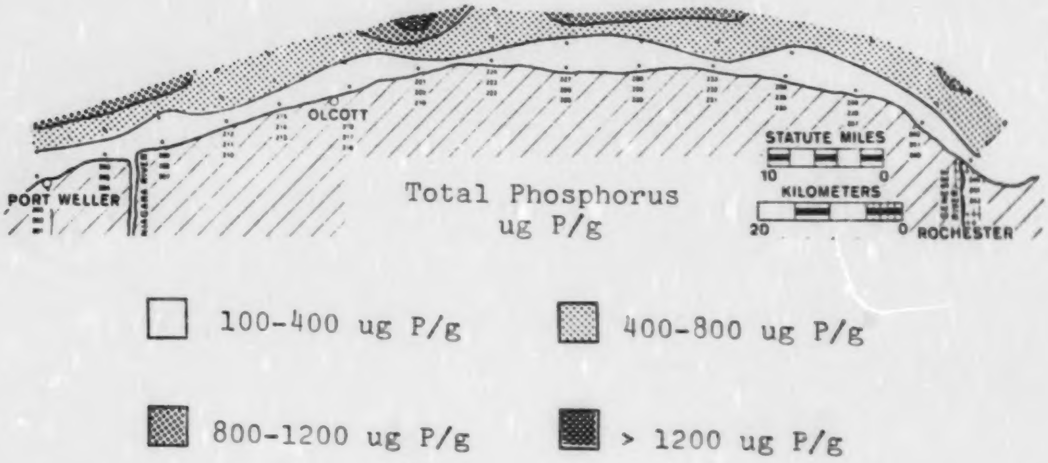

PORT WELLER
NIAGARA RIVER
OLCOTT
STATUTE MILES
10
0
KILOMETERS
20
0
GENESEE RIVER
ROCHESTER
Total Phosphorus
ug P/g
☐ 100-400 ug P/g
▨ 400-800 ug P/g
▨ 800-1200 ug P/g
■ > 1200 ug P/g

Figure 31. Sediment phosphorus content nearshore zone Southwestern Lake Ontario cruise VI 5-13 September 1972

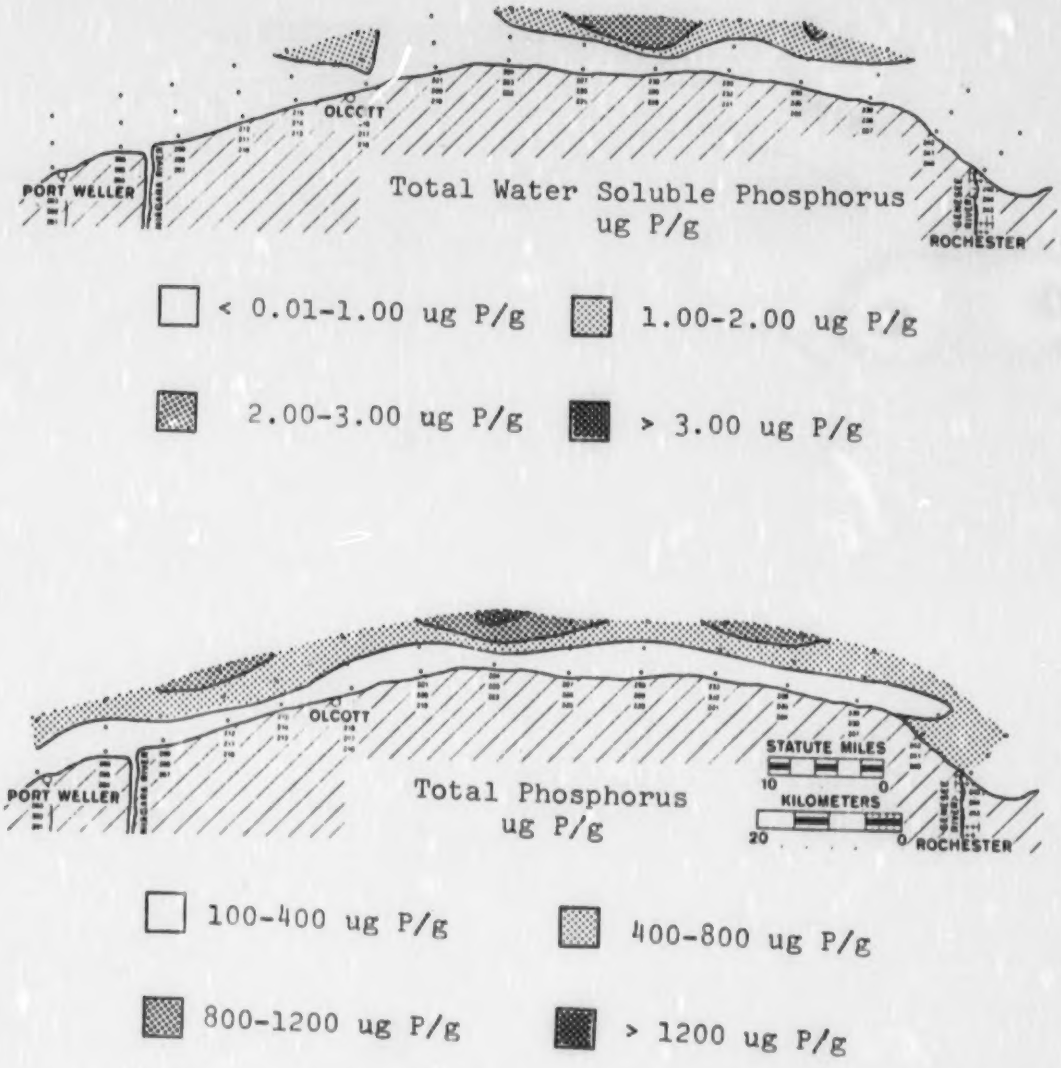

OLCOTT
PORT WELLER
NIAGARA RIVER
GENESEE RIVER
ROCHESTER
Total Water Soluble Phosphorus ug P/g
☐ < 0.01-1.00 ug P/g
▨ 1.00-2.00 ug P/g
▨ 2.00-3.00 ug P/g
■ > 3.00 ug P/g
OLCOTT
PORT WELLER
NIAGARA RIVER
GENESEE RIVER
ROCHESTER
STATUTE MILES
10
0
KILOMETERS
20
0
Total Phosphorus ug P/g
☐ 100-400 ug P/g
▨ 400-800 ug P/g
▨ 800-1200 ug P/g
■ > 1200 ug P/g

Figure 32. Sediment phosphorus content nearshore zone
Southwestern Lake Ontario cruise IX
6-22 November 1972

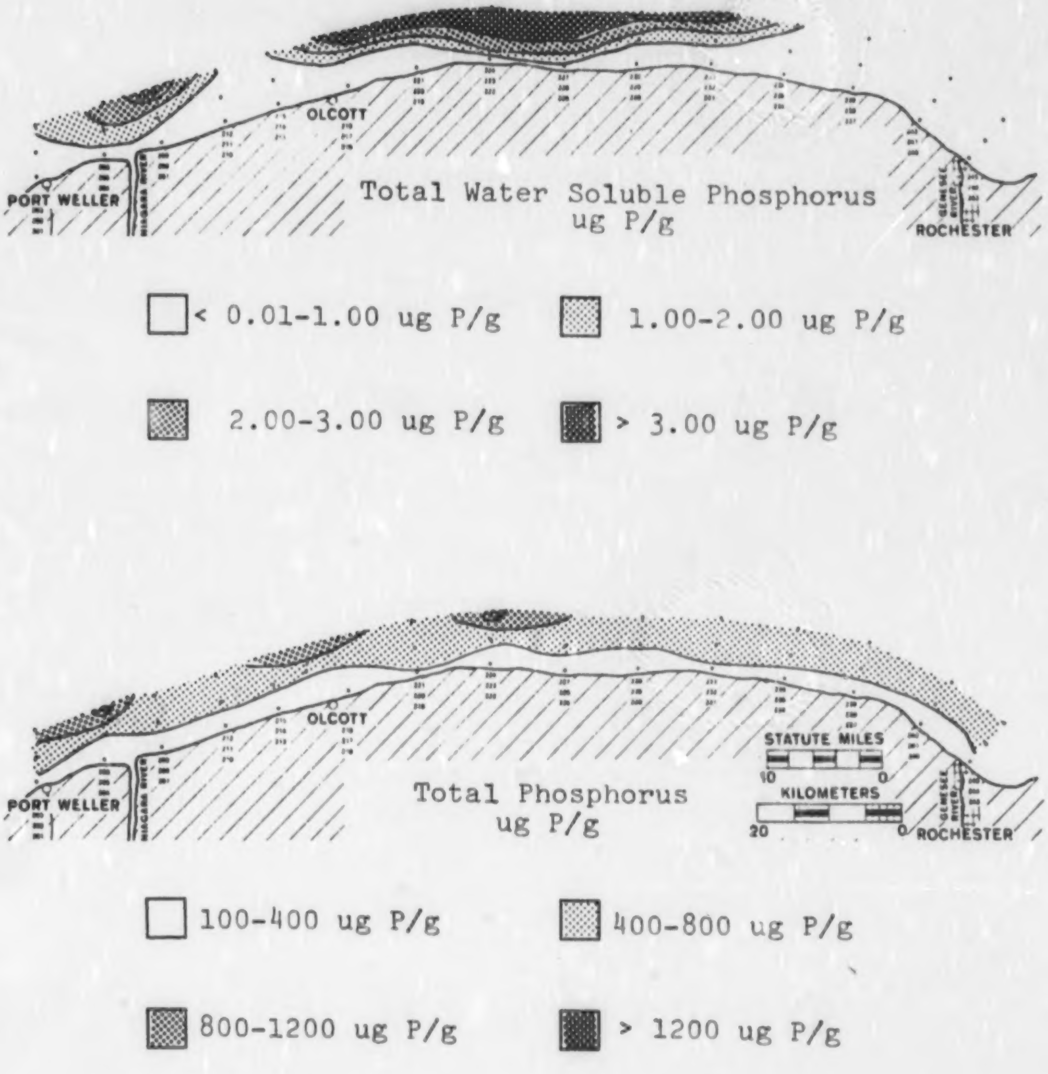
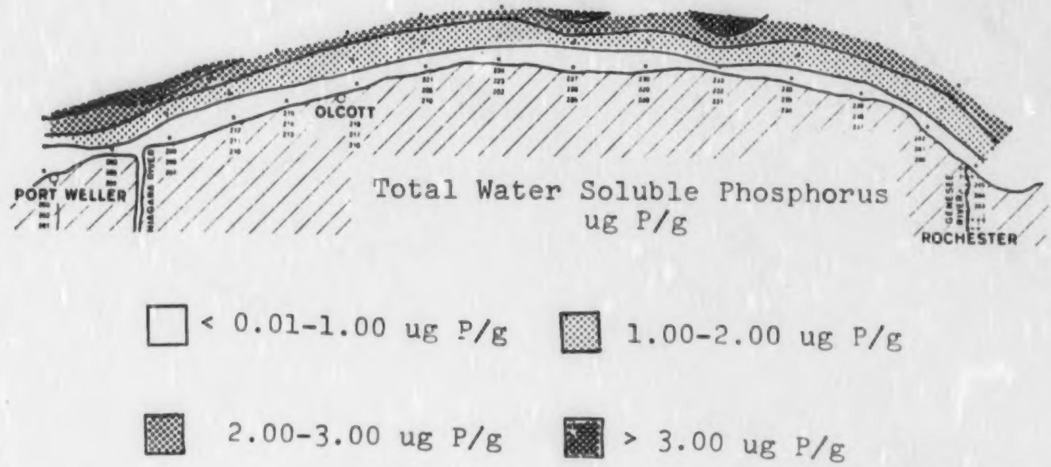
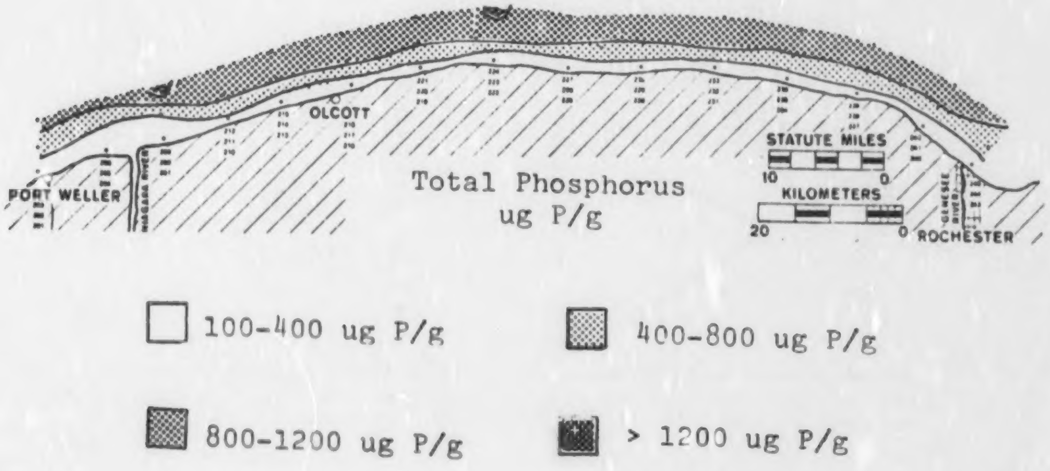

OLCOTT
PORT WELLER
ROCHESTER
Total Water Soluble Phosphorus
ug P/g
☐ < 0.01-1.00 ug P/g
░ 1.00-2.00 ug P/g
▒ 2.00-3.00 ug P/g
▓ > 3.00 ug P/g
OLCOTT
PORT WELLER
ROCHESTER
STATUTE MILES
10
0
KILOMETERS
20
0
Total Phosphorus
ug P/g
☐ 100-400 ug P/g
░ 400-800 ug P/g
▒ 800-1200 ug P/g
▓ > 1200 ug P/g

Figure 33. Sediment phosphorus content nearshore zone
Southwestern Lake Ontario cruise XI
3-25 April 1973


OLCOTT
PORT WELLER
NIAGARA RIVER
GENESEE RIVER
ROCHESTER
Total Water Soluble Phosphorus
ug P/g
< 0.01-1.00 ug P/g
1.00-2.00 ug P/g
2.00-3.00 ug P/g
> 3.00 ug P/g


OLCOTT
PORT WELLER
NIAGARA RIVER
GENESEE RIVER
ROCHESTER
STATUTE MILES
10
0
KILOMETERS
20
0
Total Phosphorus
ug P/g
100-400 ug P/g
400-800 ug P/g
800-1200 ug P/g
> 1200 ug P/g

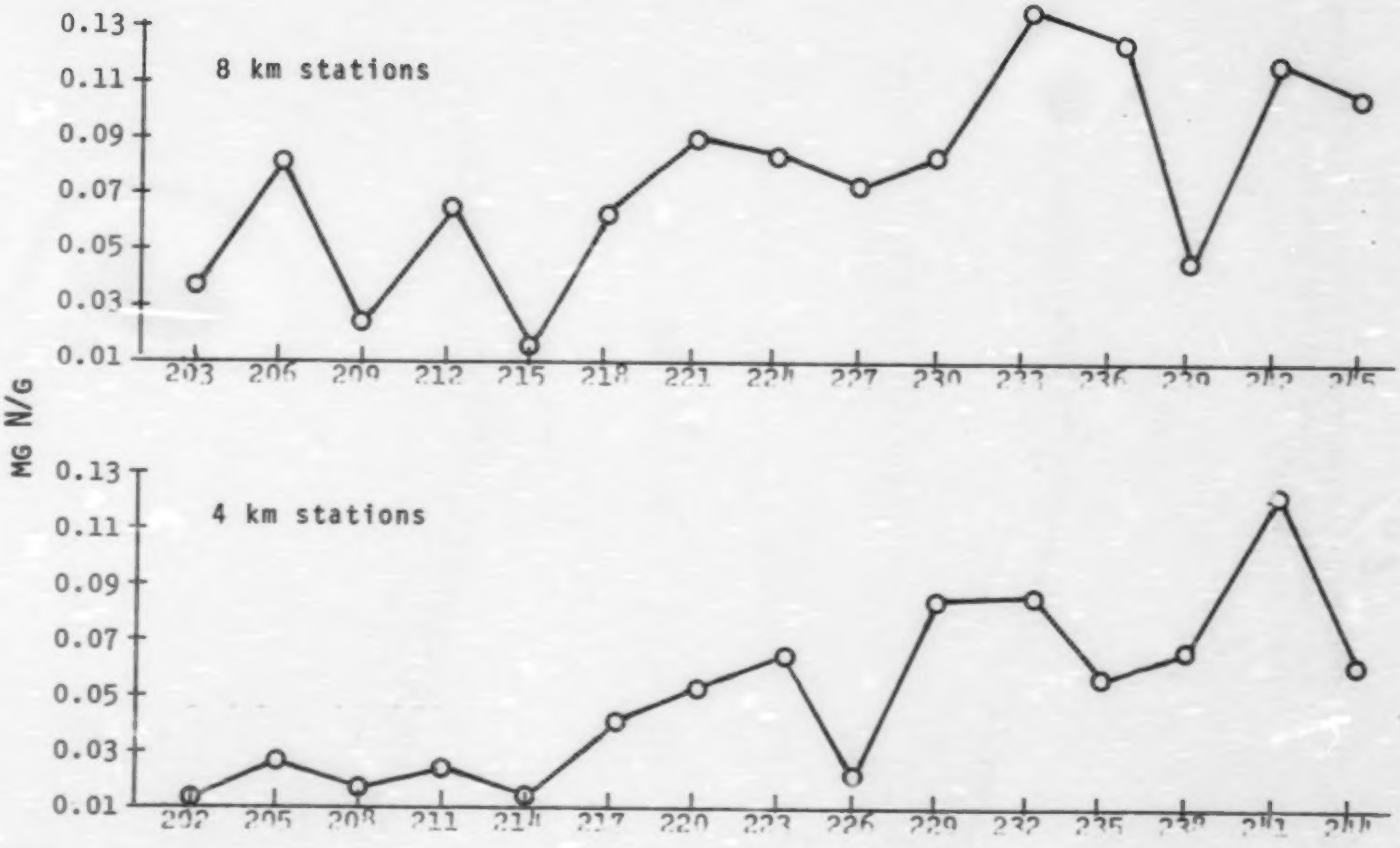


Figure 24. Mean NO_3-N concentrations in Lake Ontario sediment 1972-1973 IFYGL

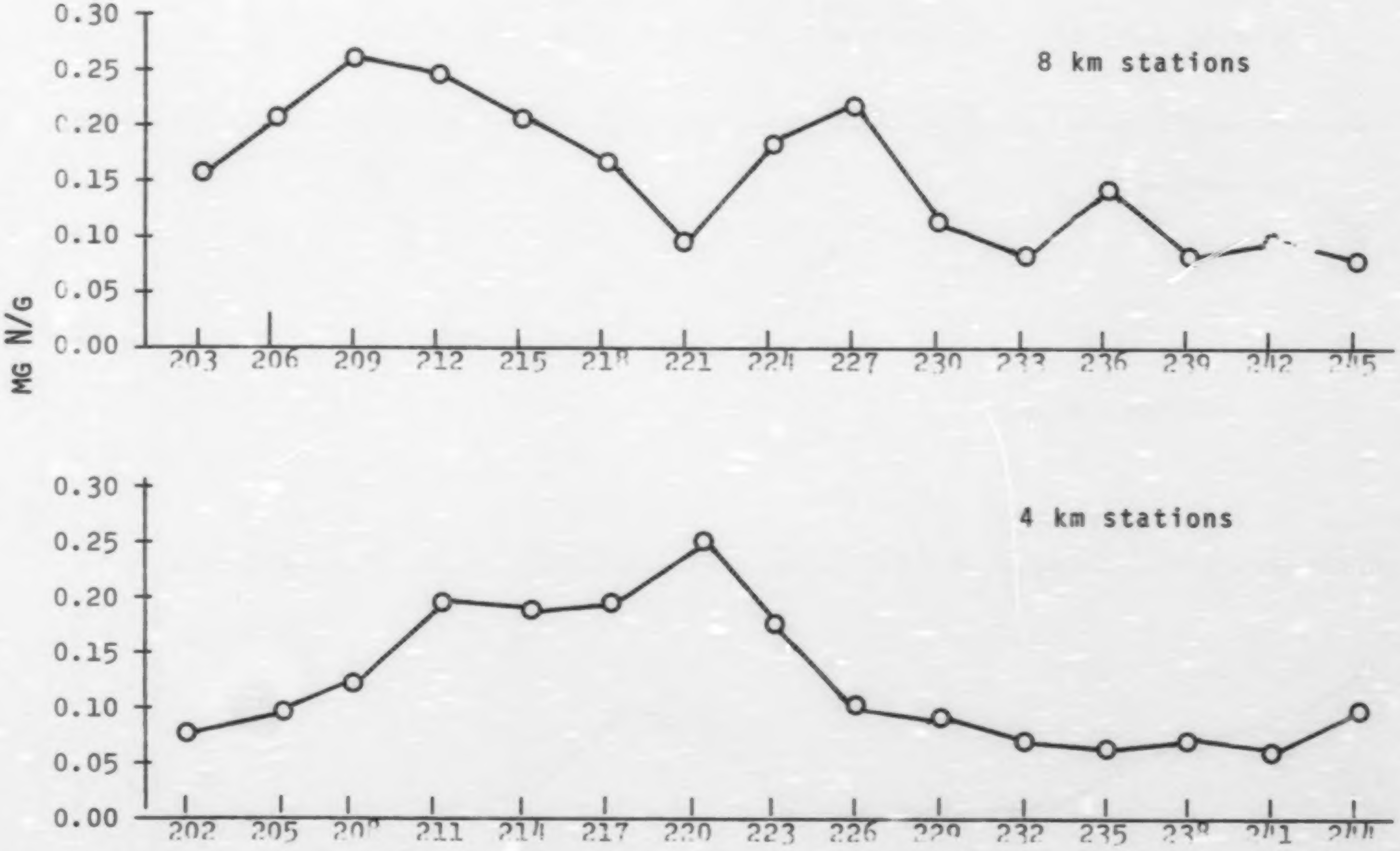


Figure 35. Mean NH_3-N concentrations in Lake Ontario sediment 1972-1973 IFYGL

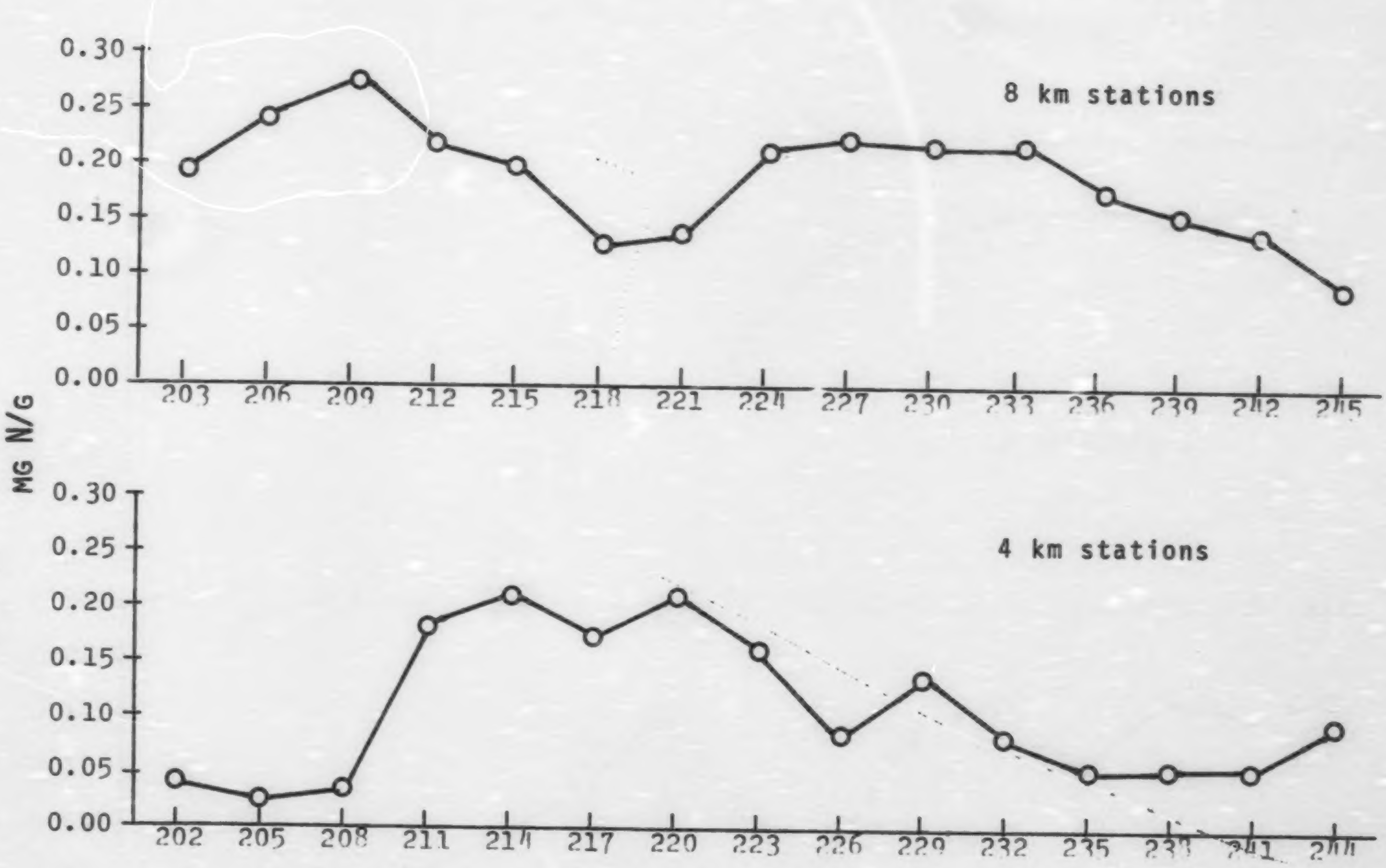


Figure 36. Mean organic-N concentrations in Lake Ontario sediment 1972-1973 IFYGL

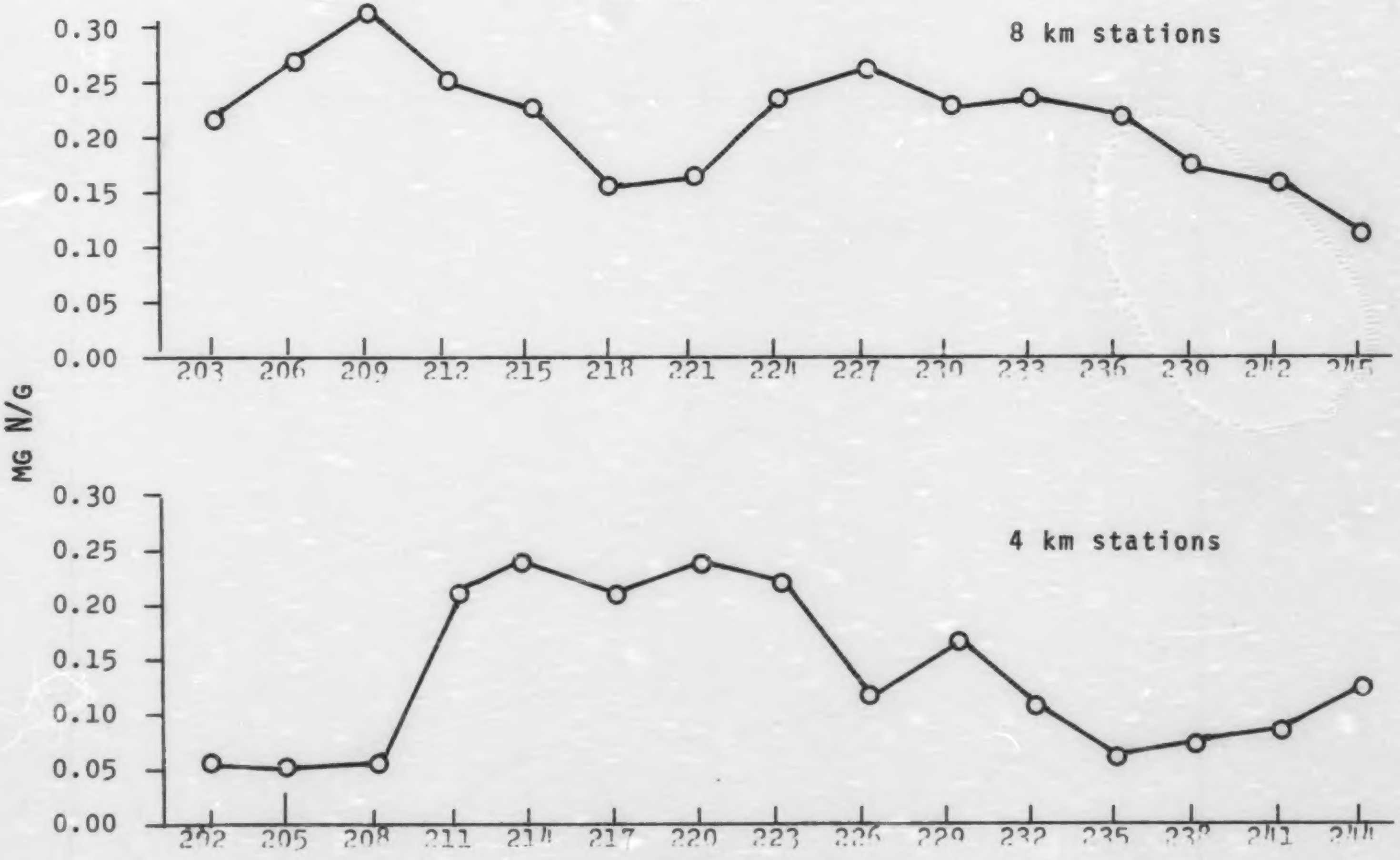


Figure 37. Mean total-N concentrations in Lake Ontario sediment 1972-1973 IFYGL

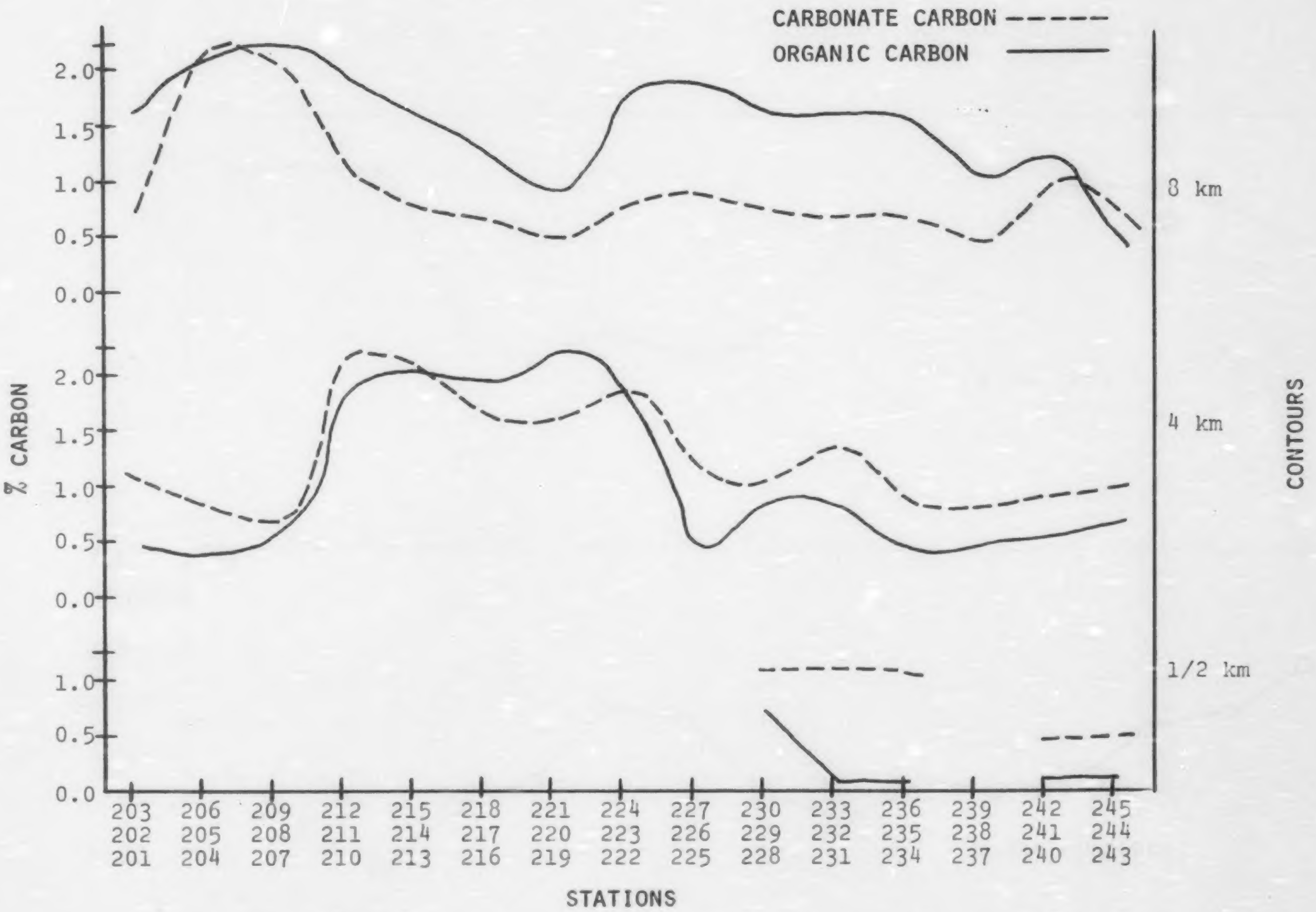


Figure 38. Mean nearshore carbonate and organic carbon (%)

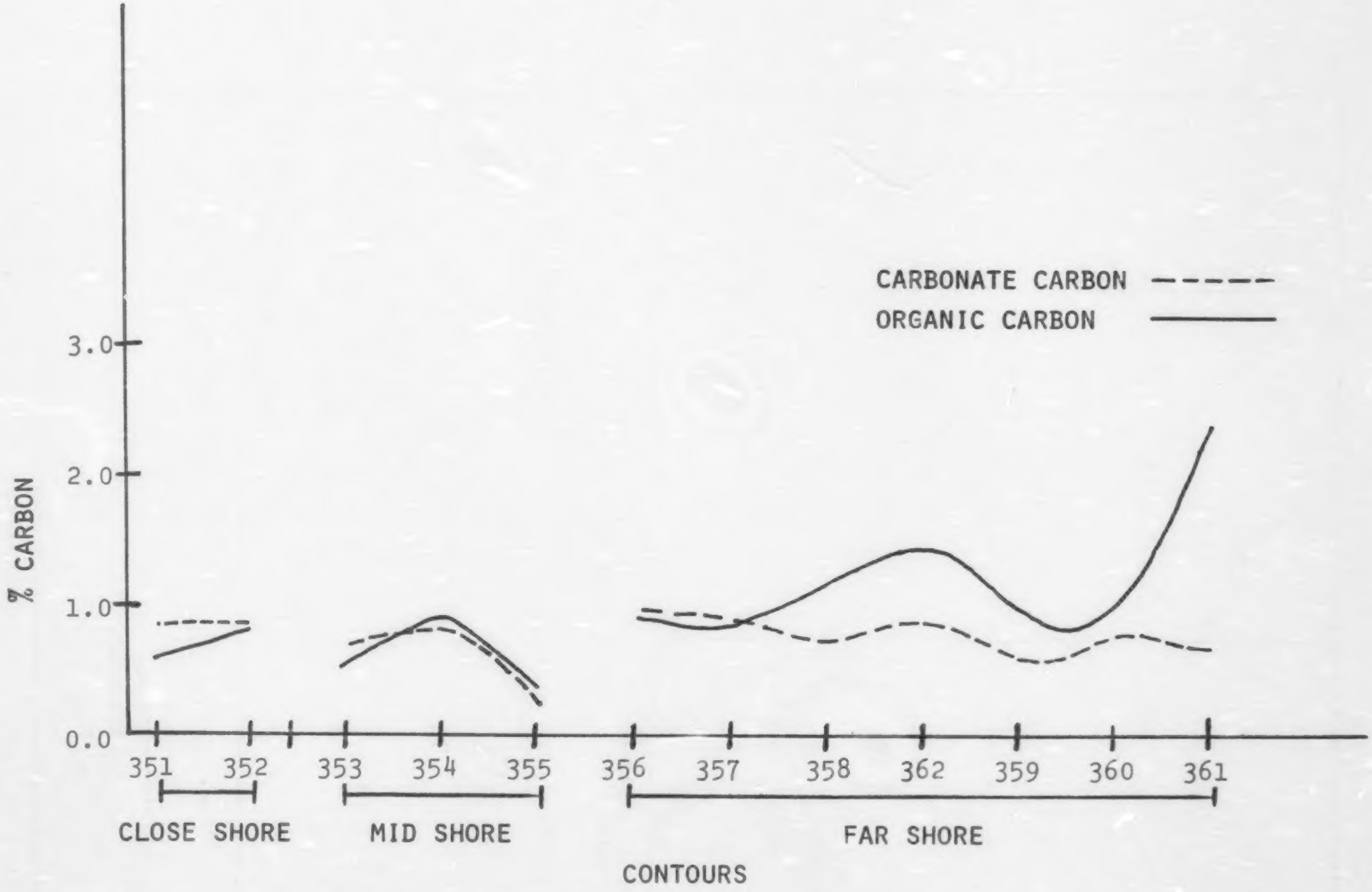
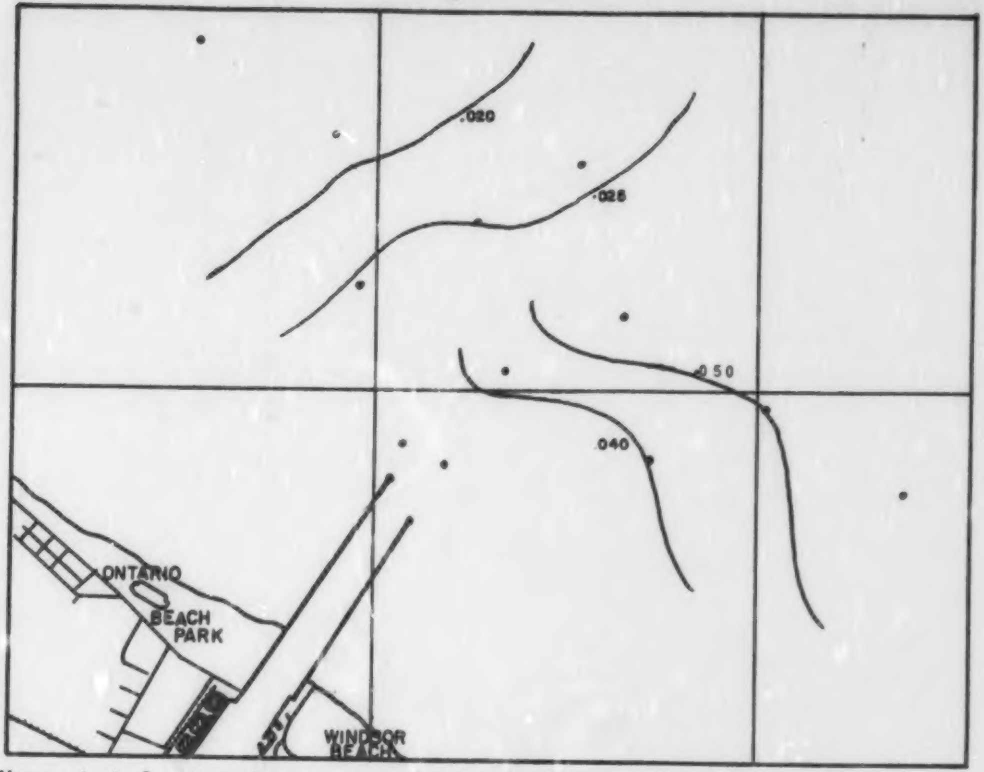
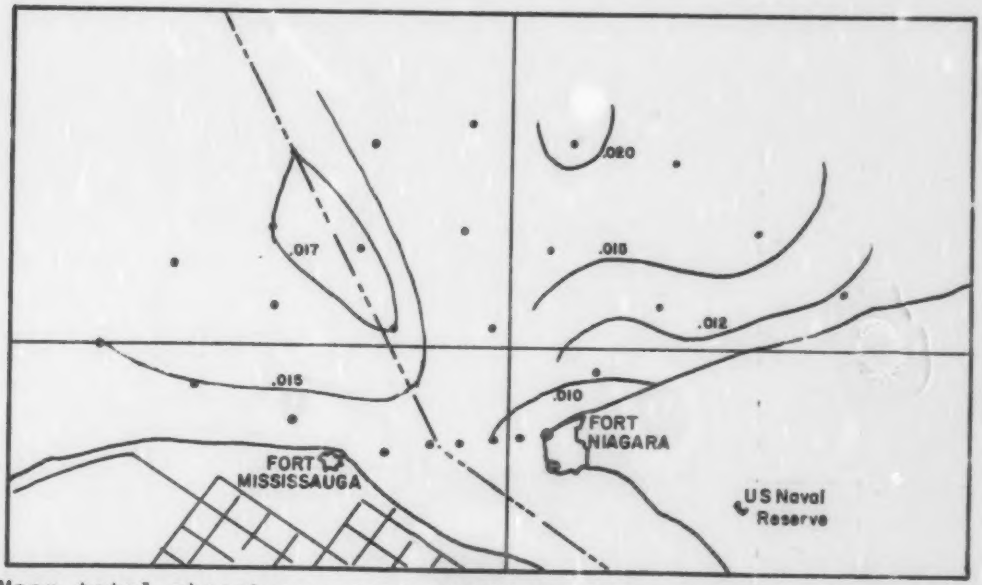


Figure 39. Mean Genesee River mouth carbonate and organic carbon (%)

Figure 40

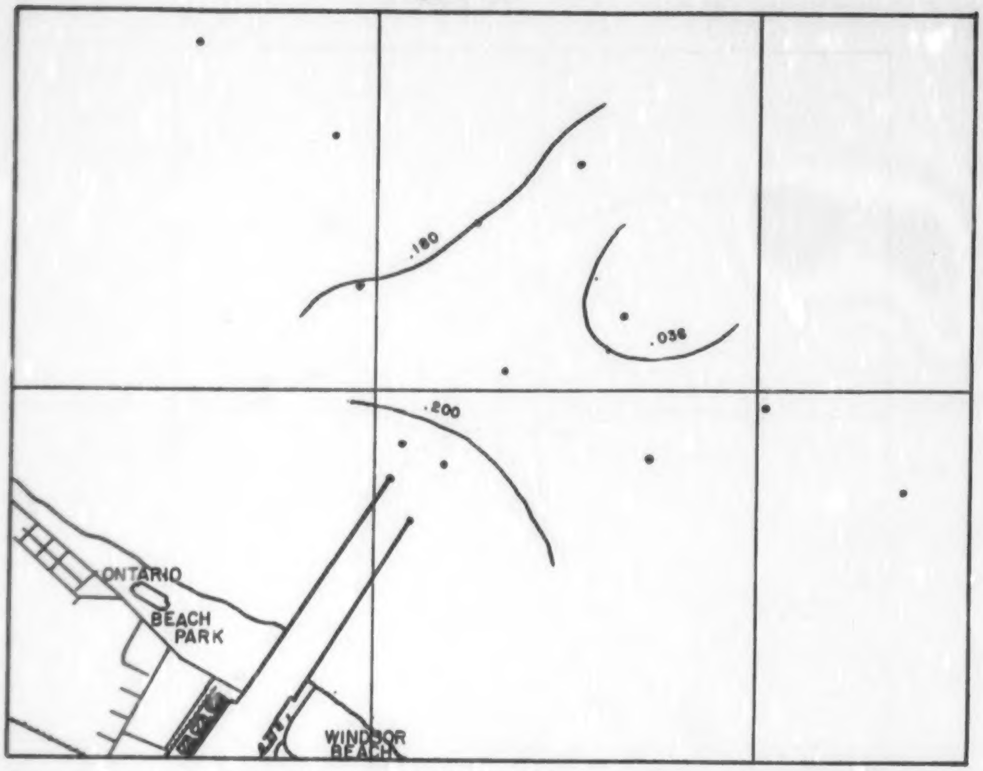

.020
.025
.050
.040
ONTARIO BEACH PARK
WINDSOR BEACH

Mean total phosphorus concentrations in mg P/l for the Genesee River mouth during the unithermal period of 1972, cruise I

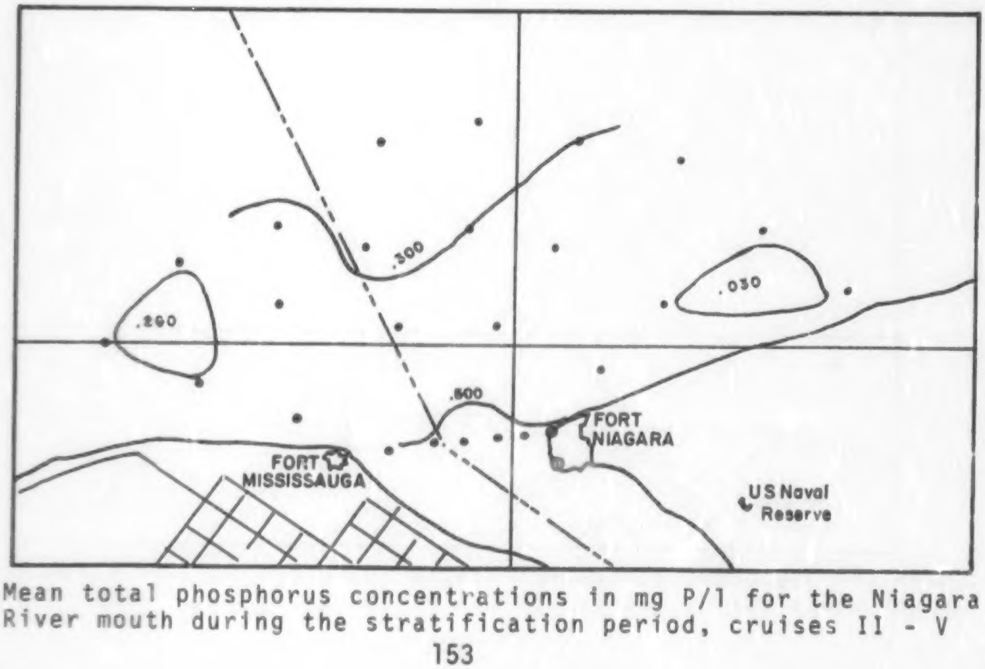

.020
.017
.015
.012
.015
.010
FORT NIAGARA
FORT MISSISSAUGA
US Naval Reserve

Mean total phosphorus concentrations in mg P/l for the Niagara River mouth during the unithermal period of 1972, cruise I

Figure 41

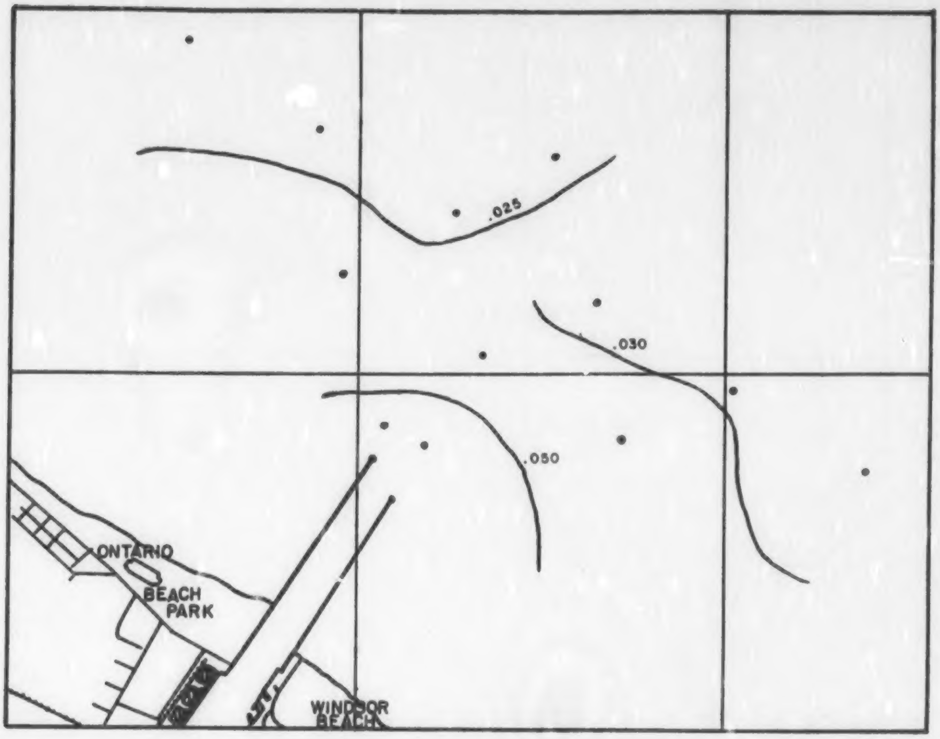

.180
.036
.200
ONTARIO
BEACH
PARK
WINDSOR
BEACH

Mean total phosphorus concentrations in mg P/l for the Genesee River mouth during the stratification period, cruises II and III

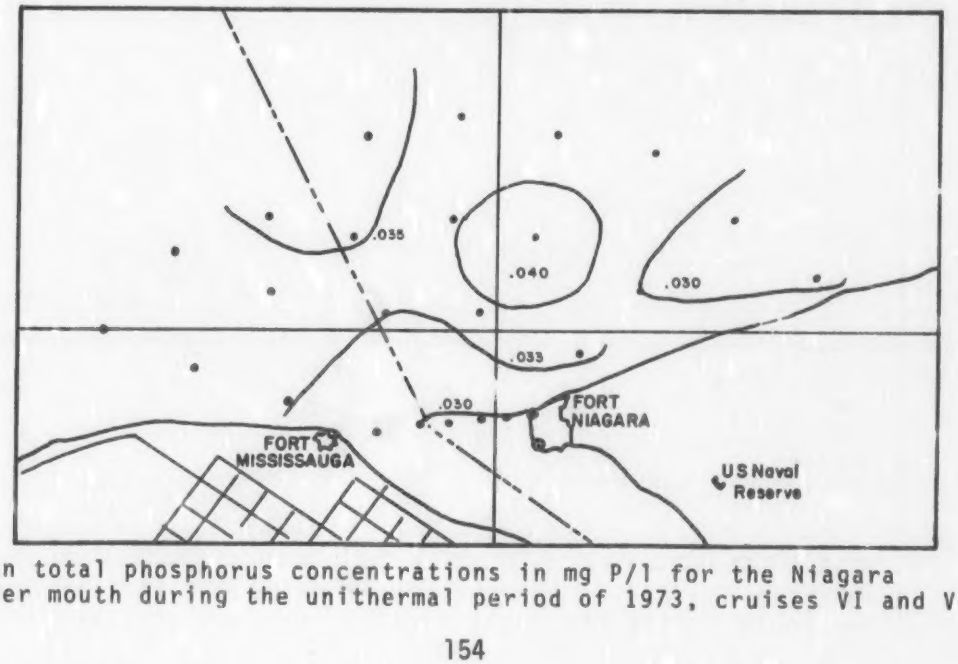

.300
.030
.260
.500
FORT
NIAGARA
FORT
MISSISSAUGA
US Naval
Reserve

Mean total phosphorus concentrations in mg P/l for the Niagara River mouth during the stratification period, cruises II - V

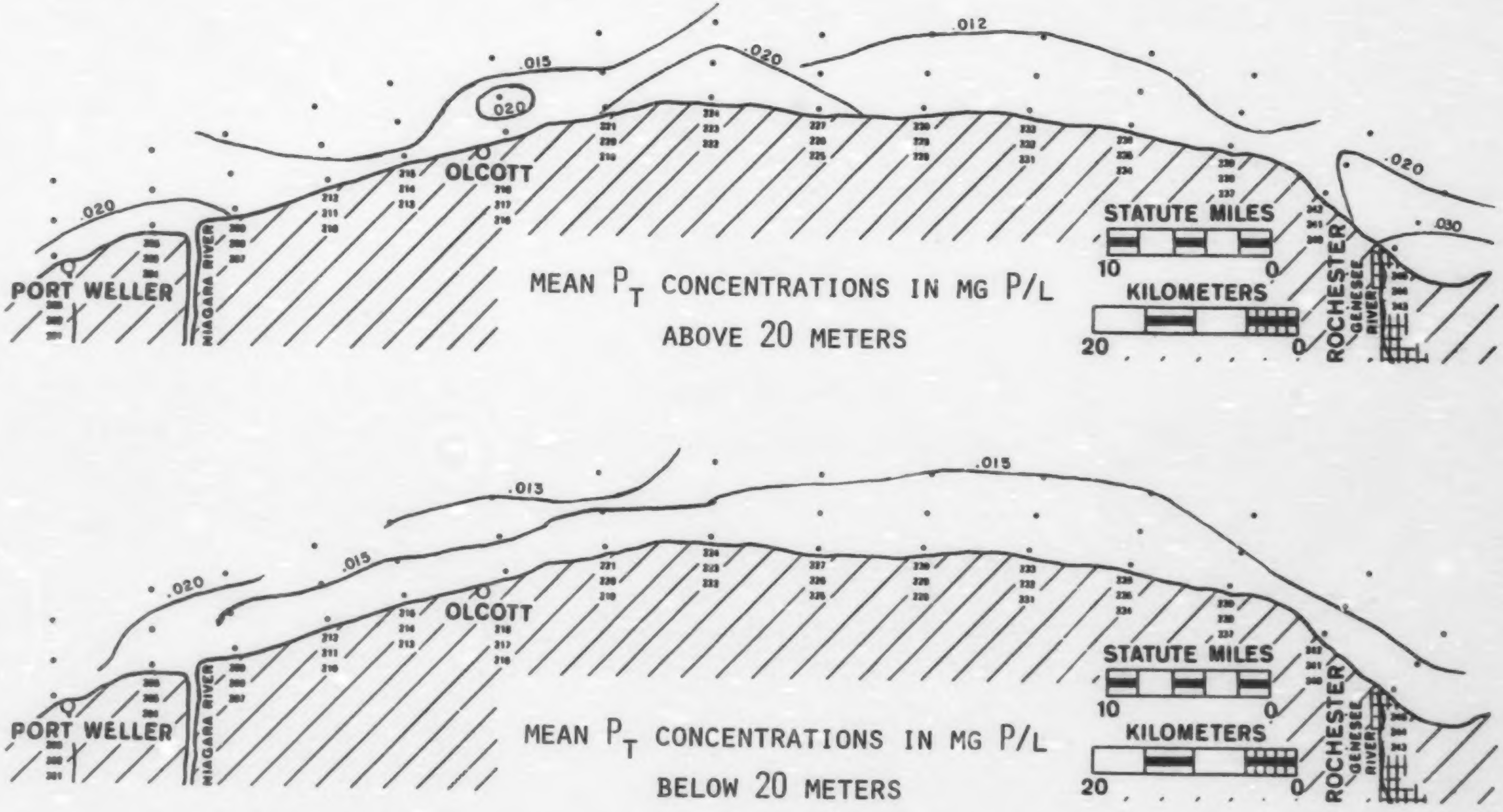
Figure 42


.025
.030
.050
ONTARIO
BEACH
PARK
WINDSOR
BEACH

Mean total phosphorus concentrations in mg P/l for the Genesee River mouth during the unithermal period of 1973, cruises VIII and IX

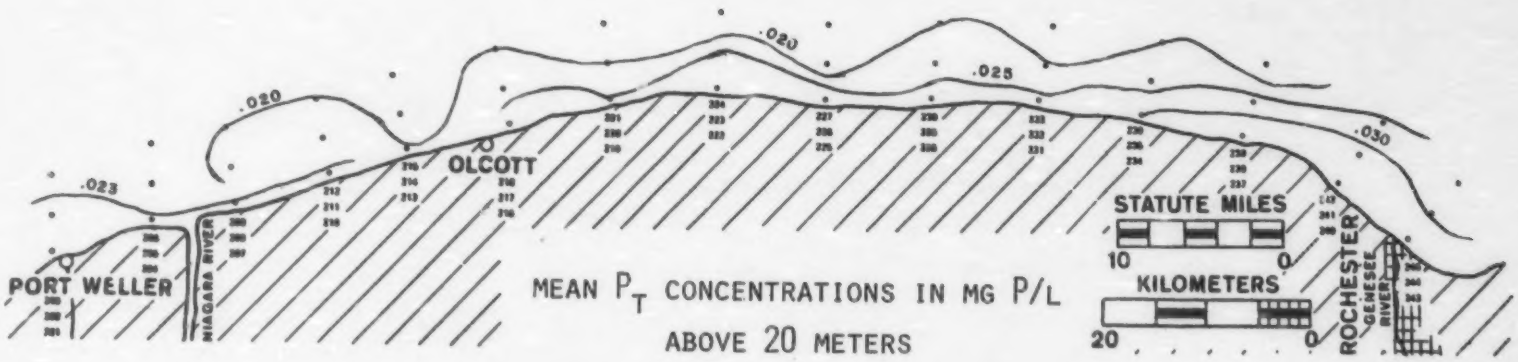

.035
.040
.030
.033
.030
FORT
NIAGARA
FORT
MISSISSAUGA
US Naval
Reserve

Mean total phosphorus concentrations in mg P/l for the Niagara River mouth during the unithermal period of 1973, cruises VI and VII

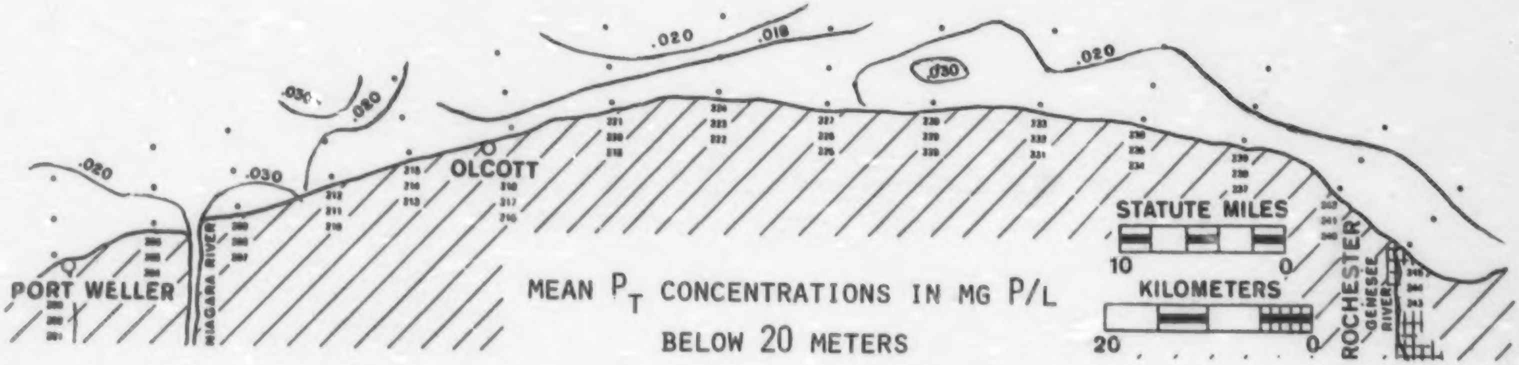


.015
.020
.020
.012
.020
.030
.020
PORT WELLER
NIAGARA RIVER
OLCOTT
ROCHESTER
GENESEE RIVER
STATUTE MILES
10
0
KILOMETERS
20
0
MEAN P_T CONCENTRATIONS IN MG P/L
ABOVE 20 METERS
.013
.015
.015
.020
MEAN P_T CONCENTRATIONS IN MG P/L
BELOW 20 METERS

Figure 43. Mean total phosphorus concentrations for Lake Ontario during the unithermal period of 1972, cruises I and II


.020
.020
.025
.023
.030
PORT WELLER
NIAGARA RIVER
OLCOTT
STATUTE MILES
10
0
KILOMETERS
20
0
ROCHESTER
GENESEE RIVER

MEAN P_T CONCENTRATIONS IN MG P/L
ABOVE 20 METERS


.020
.018
.030
.020
.030
.030
.020
.030
PORT WELLER
NIAGARA RIVER
OLCOTT
STATUTE MILES
10
0
KILOMETERS
20
0
ROCHESTER
GENESEE RIVER

MEAN P_T CONCENTRATIONS IN MG P/L
BELOW 20 METERS

Figure 44. Mean total phosphorus concentrations for Lake Ontario during the stratification period, cruises III-VII

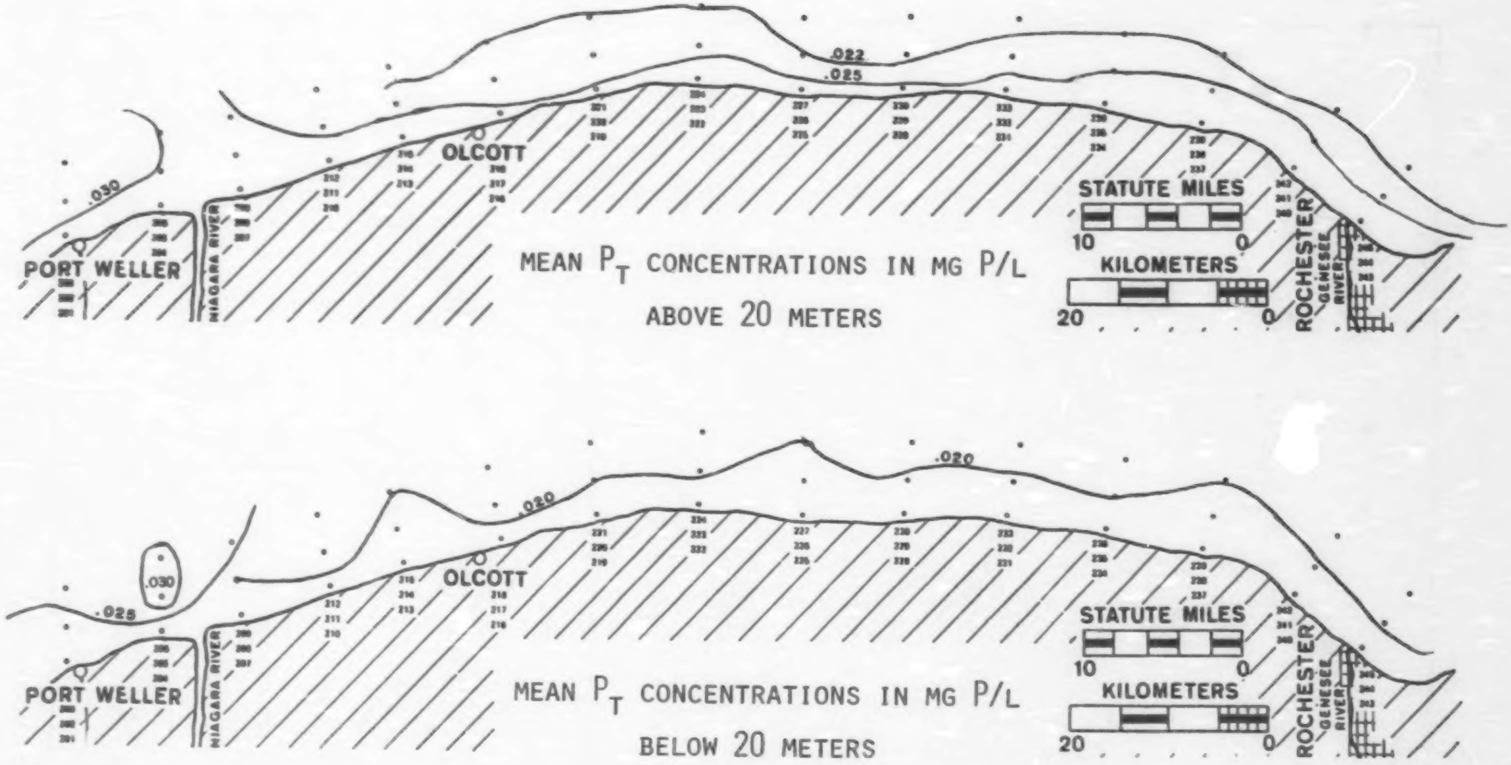
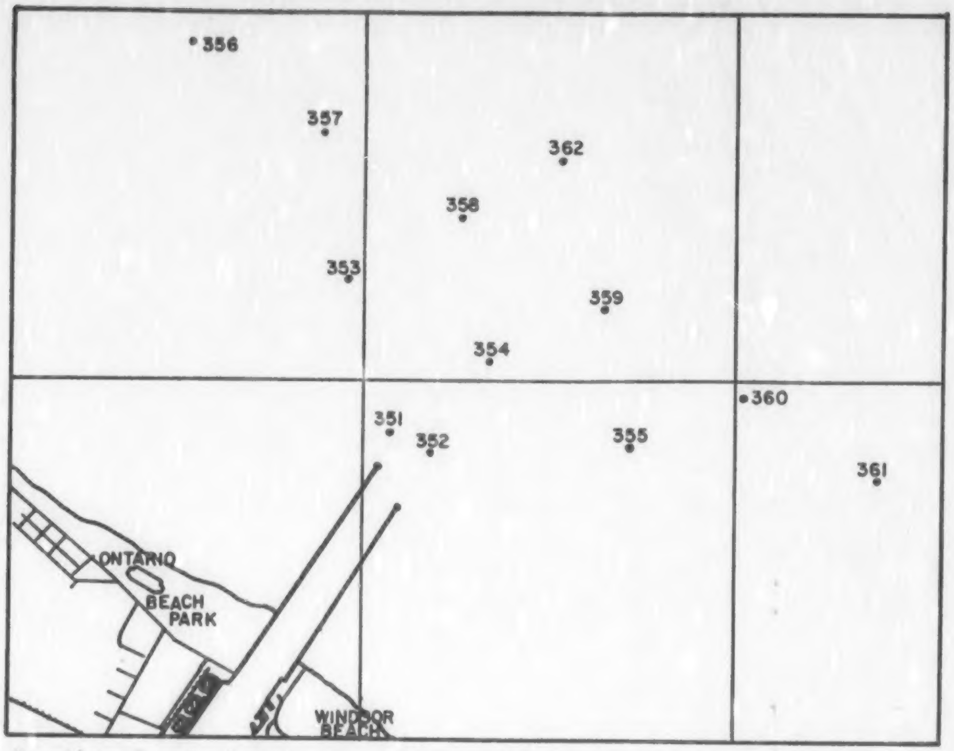
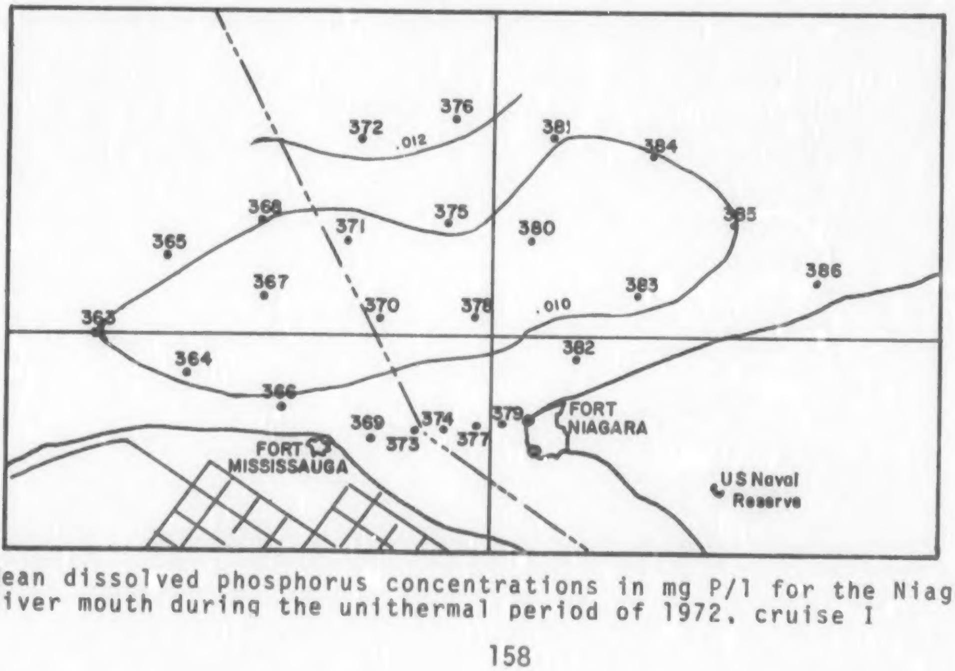

.030
.022
.025
PORT WELLER
NIAGARA RIVER
OLCOTT
STATUTE MILES
10
0
KILOMETERS
20
0
ROCHESTER
GENESEE RIVER
MEAN P_T CONCENTRATIONS IN MG P/L
ABOVE 20 METERS
.030
.025
.020
.020
PORT WELLER
NIAGARA RIVER
OLCOTT
STATUTE MILES
10
0
KILOMETERS
20
0
ROCHESTER
GENESEE RIVER
MEAN P_T CONCENTRATIONS IN MG P/L
BELOW 20 METERS

Figure 45. Mean total phosphorus concentrations for Lake Ontario during the unithermal period of 1973, cruises VIII-XIII

Figure 46

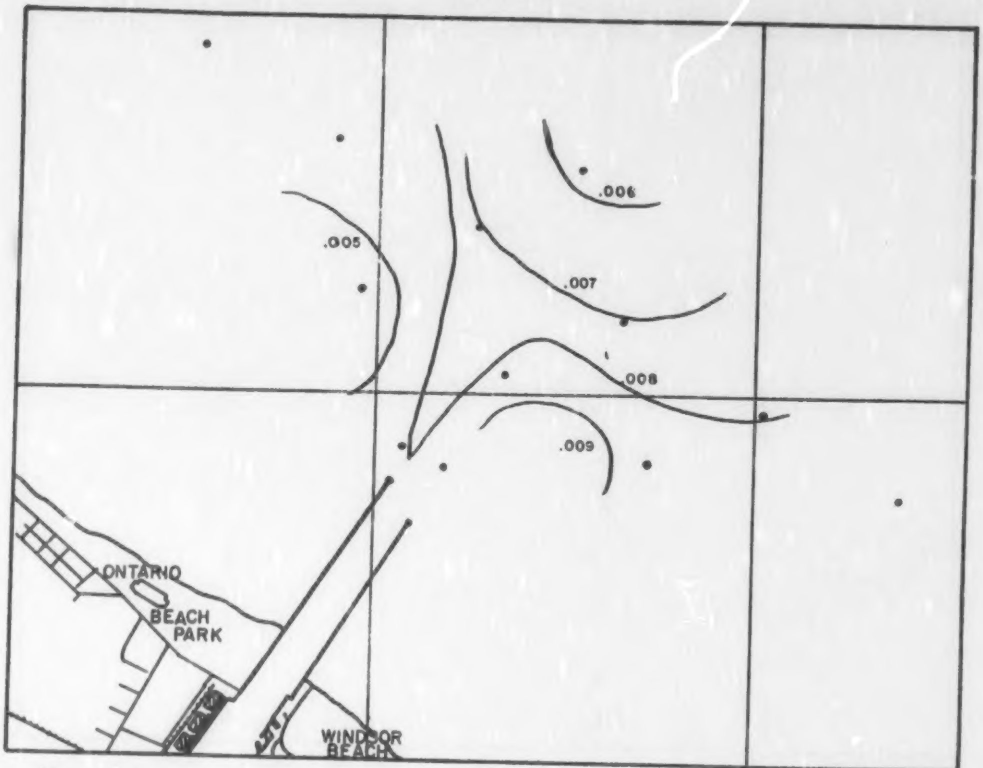

356
357
362
358
353
359
354
360
351
352
355
361
ONTARIO
BEACH
PARK
WINDSOR
BEACH

No dissolved phosphorus data available for the Genesee River during the unithermal period of 1972, cruise I

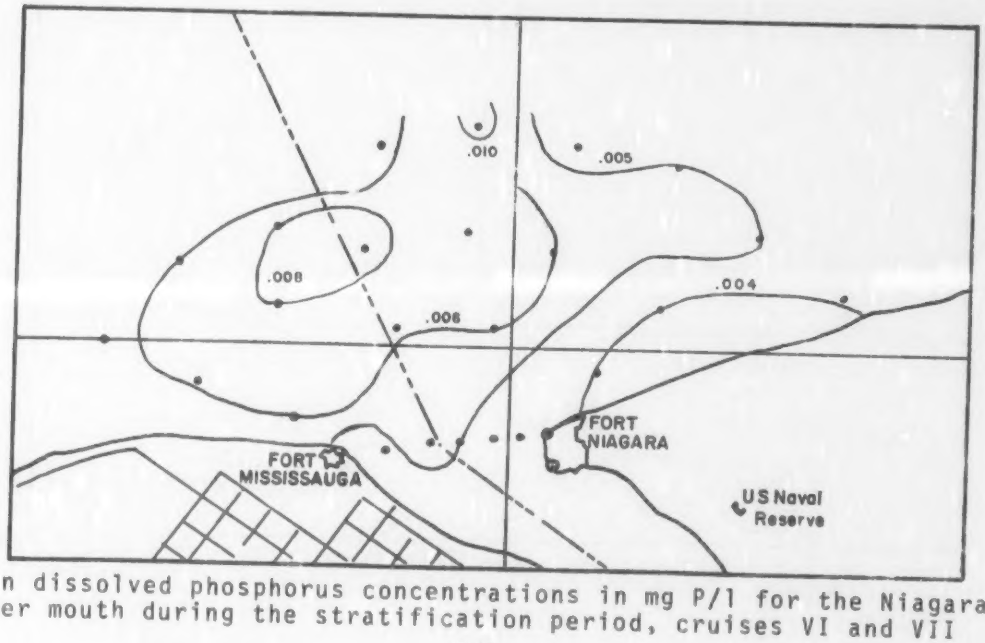

376
372
.012
381
384
368
375
371
380
385
365
386
367
383
370
378
.010
363
382
364
366
369
374
379
373
377
FORT NIAGARA
FORT MISSISSAUGA
US Naval Reserve

Mean dissolved phosphorus concentrations in mg P/l for the Niagara River mouth during the unithermal period of 1972, cruise I

Figure 47

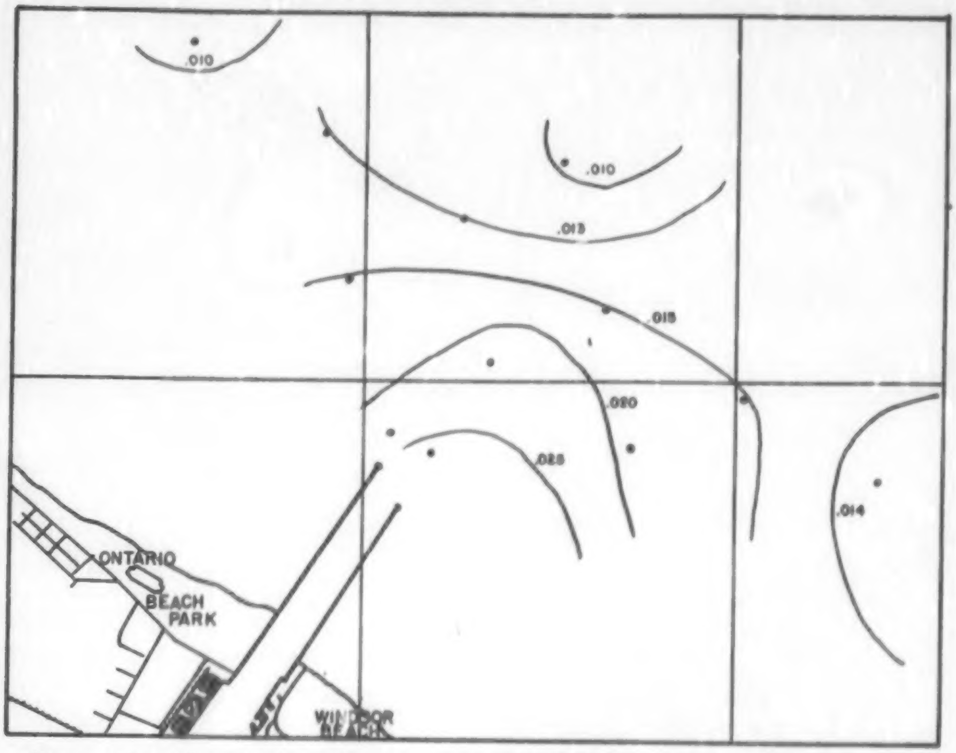

.006
.005
.007
.008
.009
ONTARIO
BEACH
PARK
WINDSOR
BEACH

Mean dissolved phosphorus concentrations in mg P/l for the Genesee River mouth during the stratification period, cruises VIII and IX

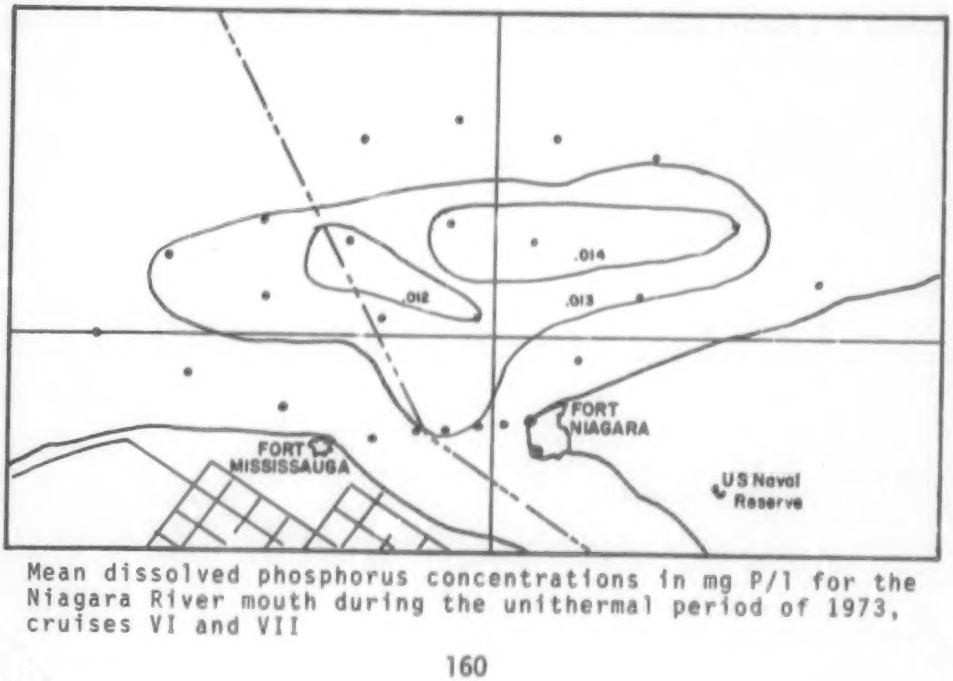

.010
.005
.008
.006
.004
FORT
NIAGARA
FORT
MISSISSAUGA
US Naval
Reserve

Mean dissolved phosphorus concentrations in mg P/l for the Niagara River mouth during the stratification period, cruises VI and VII

Figure 48


.010
.010
.013
.015
.020
.025
.014
ONTARIO
BEACH
PARK
WINDSOR
BEACH

Mean dissolved phosphorus concentrations in mg P/l for the Genesee River mouth during the unithermal period of 1973, cruises VIII and IX


.014
.012
.013
FORT
NIAGARA
FORT
MISSISSAUGA
US Naval
Reserve

Mean dissolved phosphorus concentrations in mg P/l for the Niagara River mouth during the unithermal period of 1973, cruises VI and VII

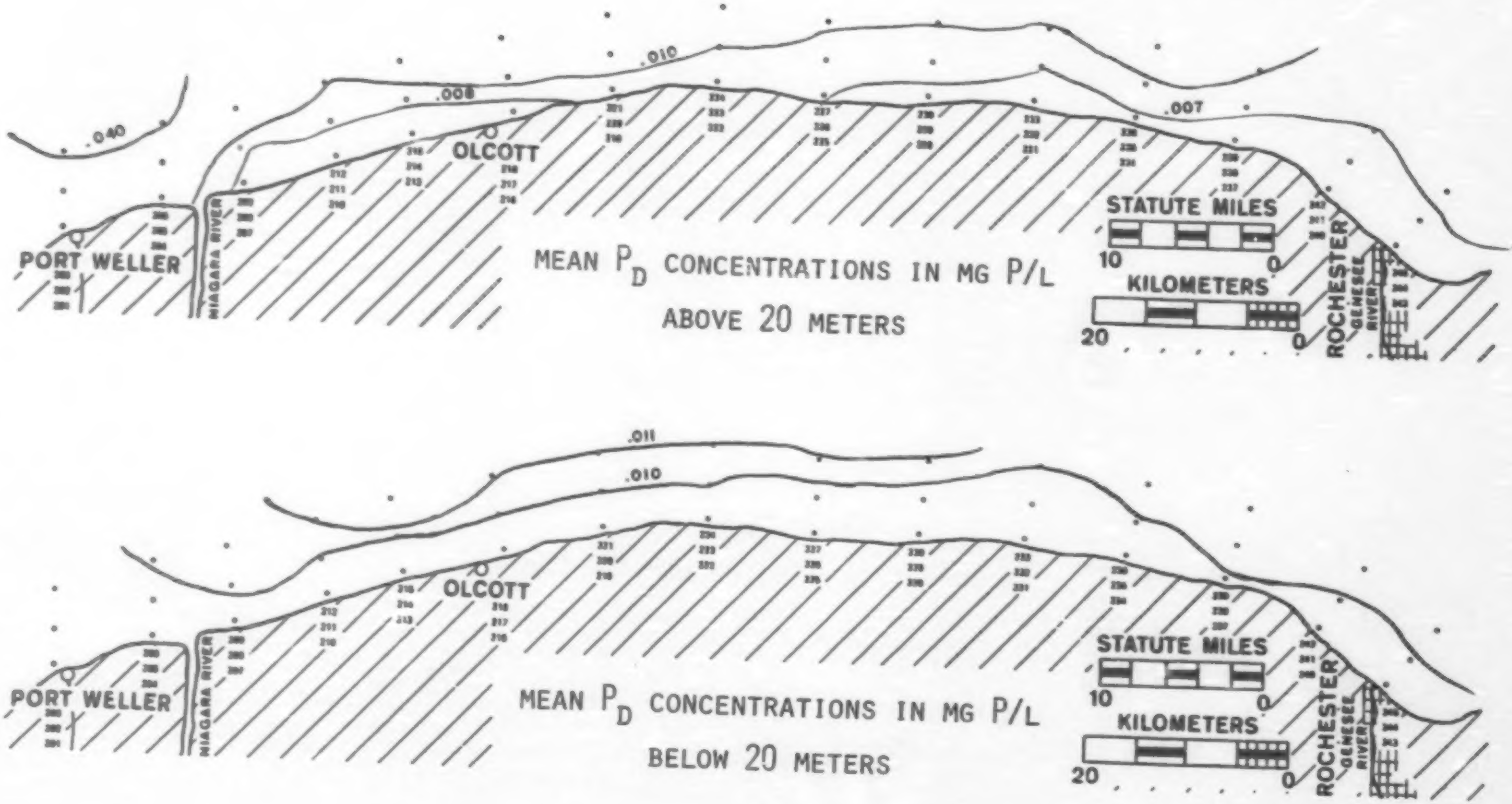

.040
.008
.010
.007
PORT WELLER
NIAGARA RIVER
OLCOTT
ROCHESTER
GENESEE RIVER
STATUTE MILES
10
0
KILOMETERS
20
0
MEAN P_D CONCENTRATIONS IN MG P/L
ABOVE 20 METERS
.011
.010
PORT WELLER
NIAGARA RIVER
OLCOTT
ROCHESTER
GENESEE RIVER
STATUTE MILES
10
0
KILOMETERS
20
0
MEAN P_D CONCENTRATIONS IN MG P/L
BELOW 20 METERS

Figure 49. Mean dissolved phosphorus concentrations for Lake Ontario during the unithermal period of 1972, cruises I and II

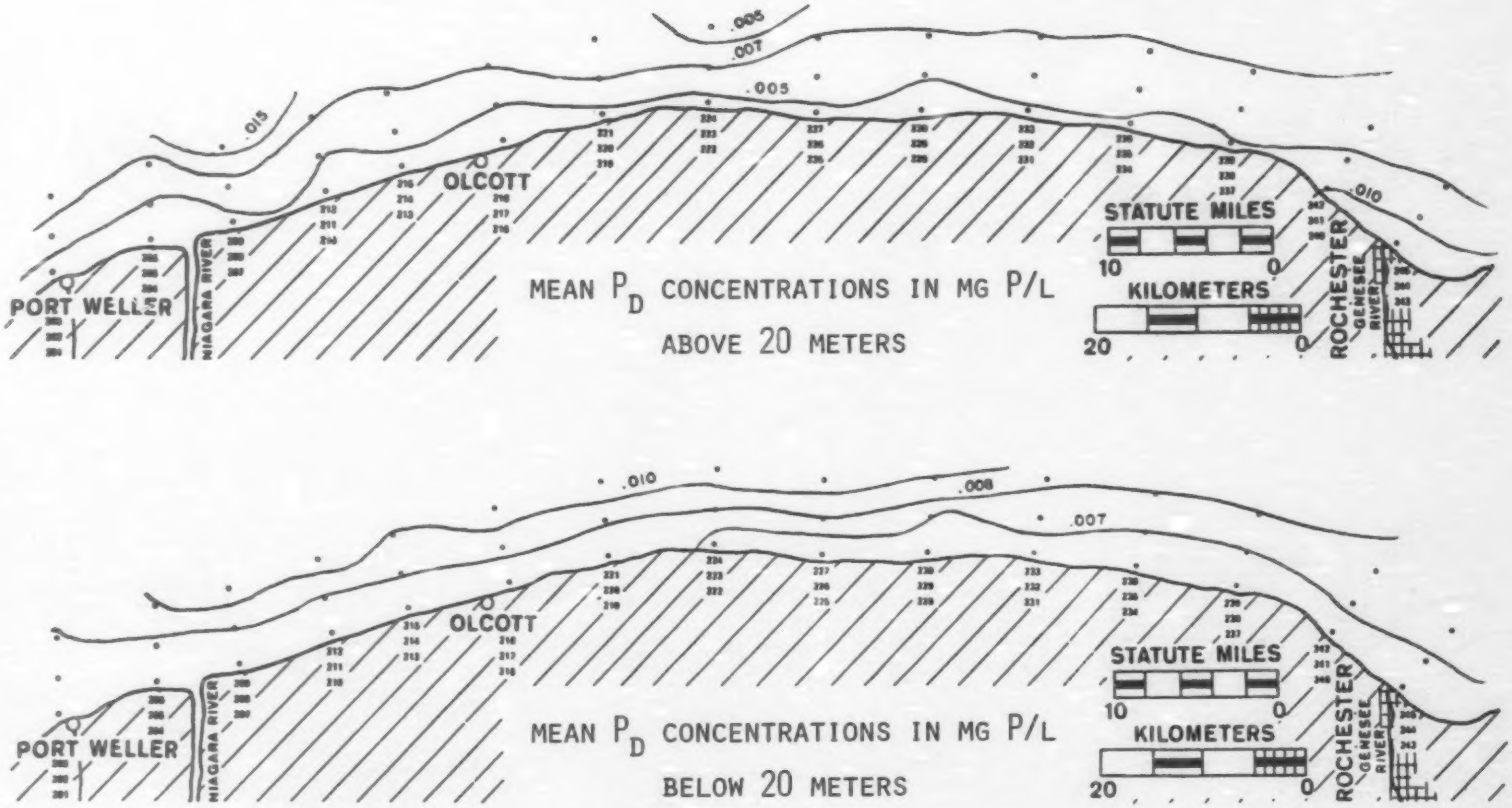

.005
.007
.005
.015
.010
OLCOTT
PORT WELLER
NIAGARA RIVER
ROCHESTER
GENESEE RIVER
STATUTE MILES
10
0
KILOMETERS
20
0
MEAN P_D CONCENTRATIONS IN MG P/L
ABOVE 20 METERS
.010
.008
.007
MEAN P_D CONCENTRATIONS IN MG P/L
BELOW 20 METERS

Figure 50. Mean dissolved phosphorus concentrations for Lake Ontario during the stratification period, cruises III-VII

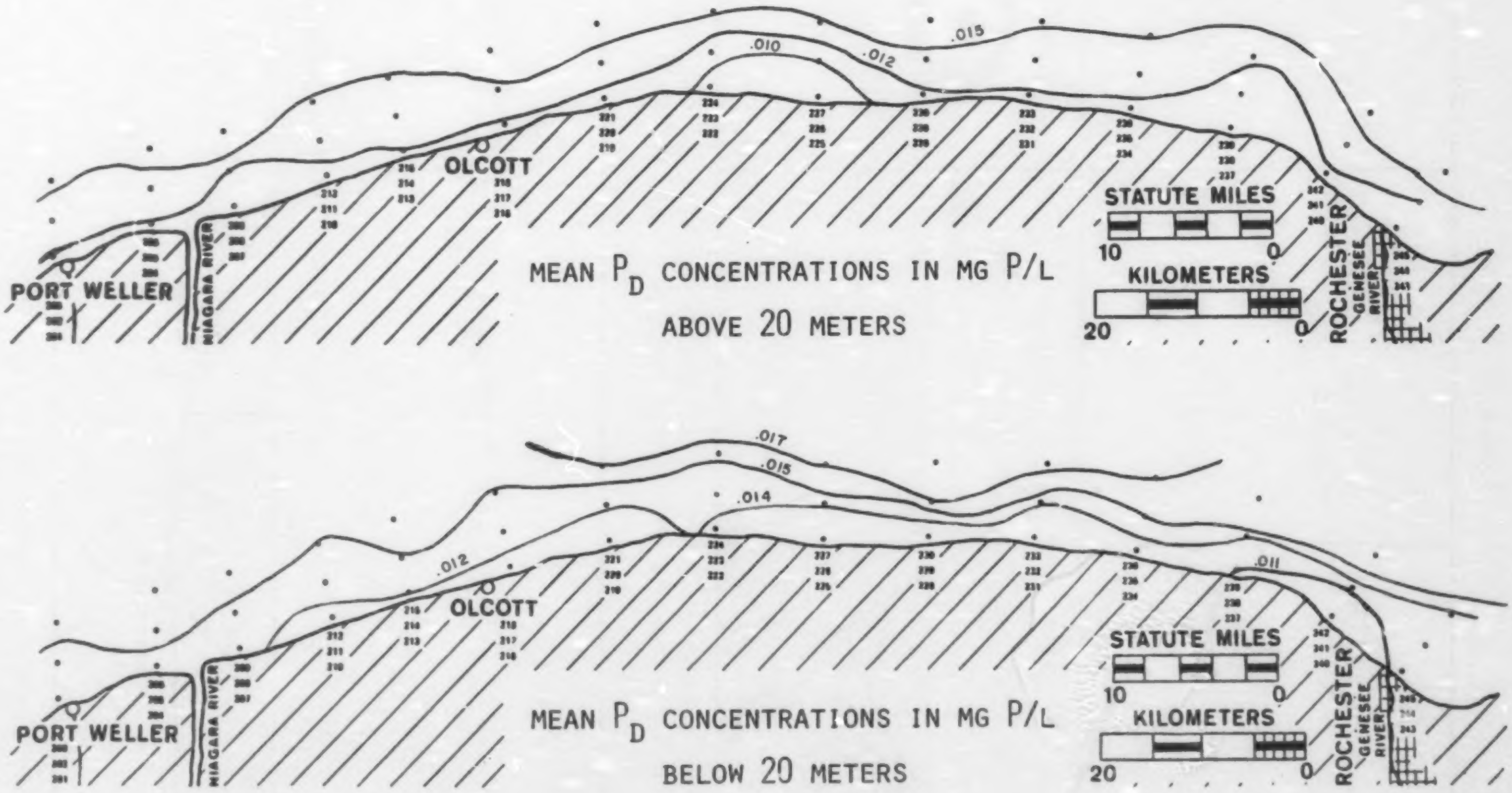
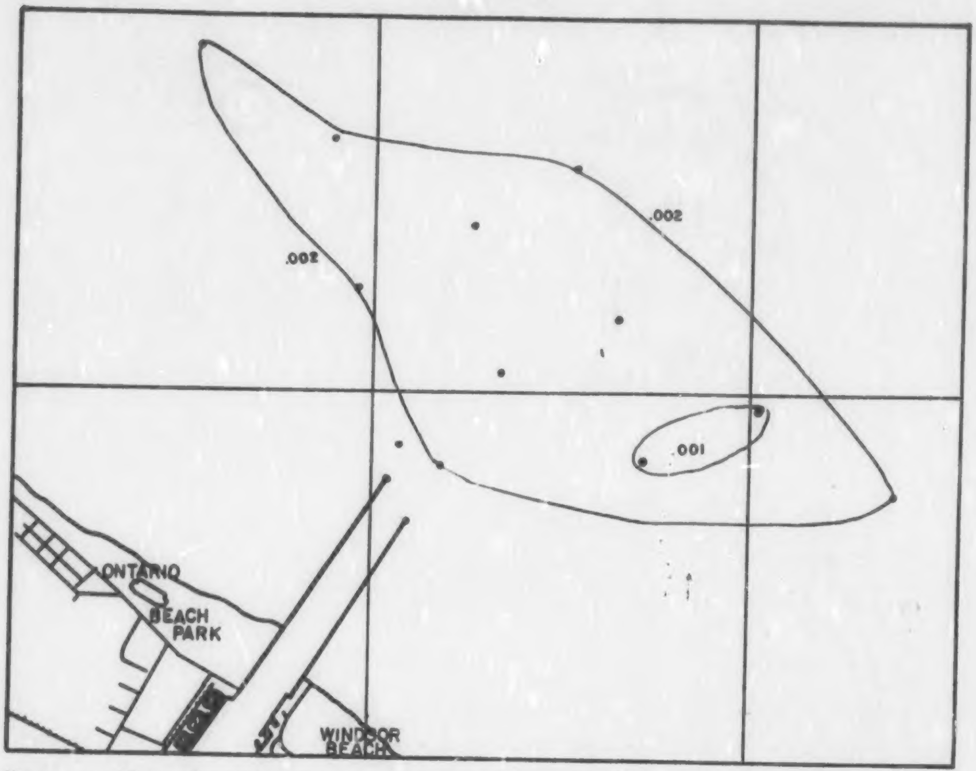
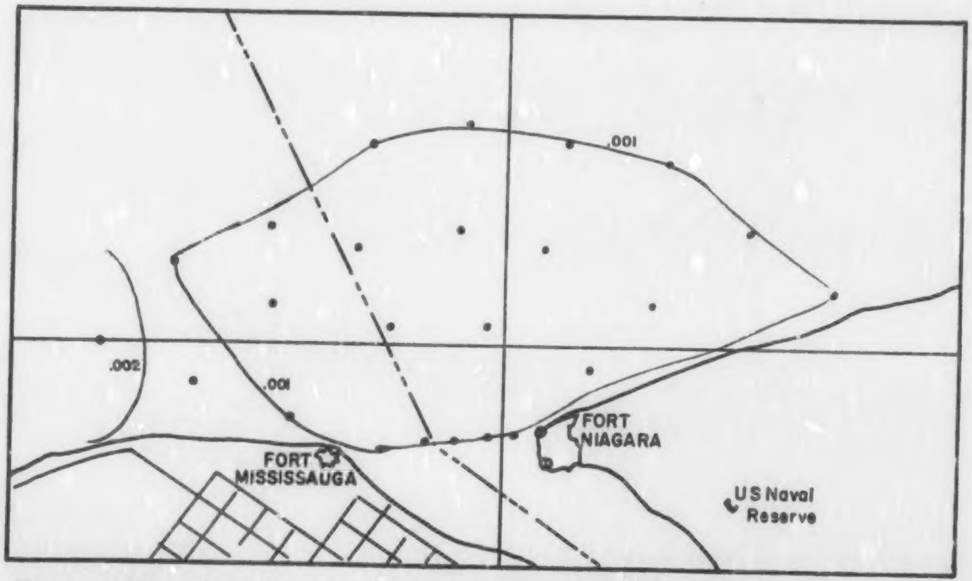

.015
.012
.010
OLCOTT
PORT WELLER
NIAGARA RIVER
ROCHESTER
GENESEE RIVER
STATUTE MILES
10
0
KILOMETERS
20
0
MEAN P_D CONCENTRATIONS IN MG P/L
ABOVE 20 METERS
.017
.015
.014
.012
.011
OLCOTT
PORT WELLER
NIAGARA RIVER
ROCHESTER
GENESEE RIVER
STATUTE MILES
10
0
KILOMETERS
20
0
MEAN P_D CONCENTRATIONS IN MG P/L
BELOW 20 METERS

Figure 51. Mean dissolved phosphorus concentrations for Lake Ontario during the unithermal period of 1973, cruises VIII-XIII

Figure 52

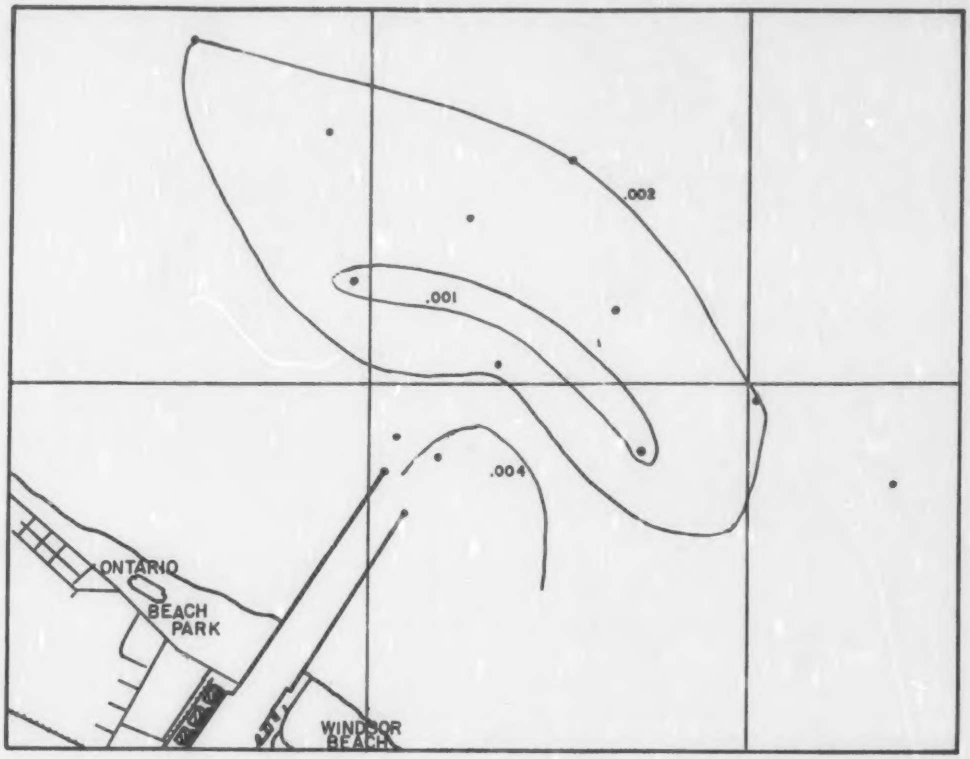

.002
.002
.001
ONTARIO
BEACH
PARK
WINDSOR
BEACH

Mean ortho phosphorus concentrations in mg P/l for the Genesee River mouth during the unithermal period of 1972, cruise I

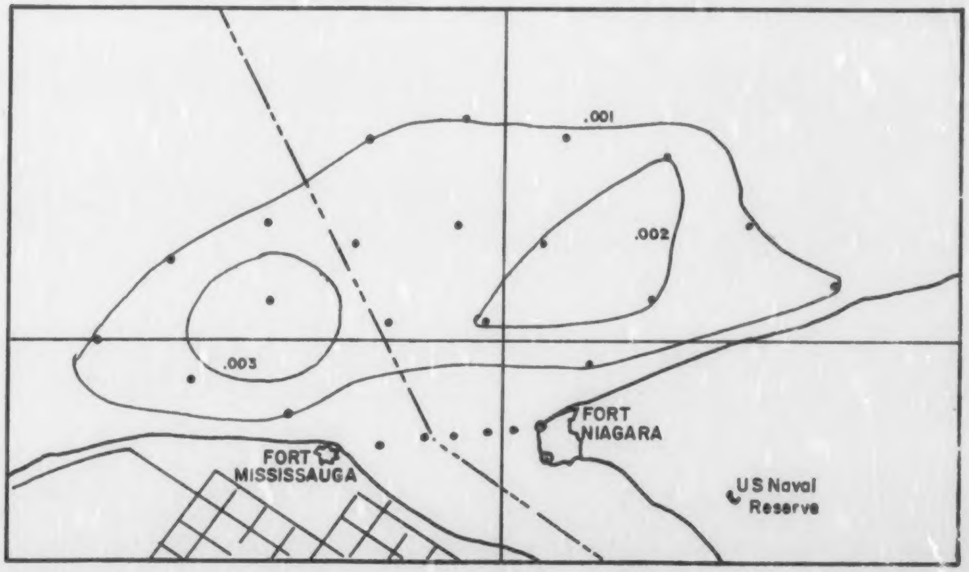

.001
.002
.001
FORT
NIAGARA
FORT
MISSISSAUGA
US Naval
Reserve

Mean ortho phosphorus concentrations in mg P/l for the Niagara River mouth during the unithermal period of 1972, cruise I

Figure 53


.002
.001
.004
ONTARIO
BEACH
PARK
WINDSOR
BEACH

Mean ortho phosphorus concentrations in mg P/l for the Genesee River mouth during the stratification period, Cruises II and III


.001
.002
.003
FORT
NIAGARA
FORT
MISSISSAUGA
US Naval
Reserve

Mean ortho phosphorus concentrations in mg P/l for the Niagara River mouth during the stratification period, cruises II - V

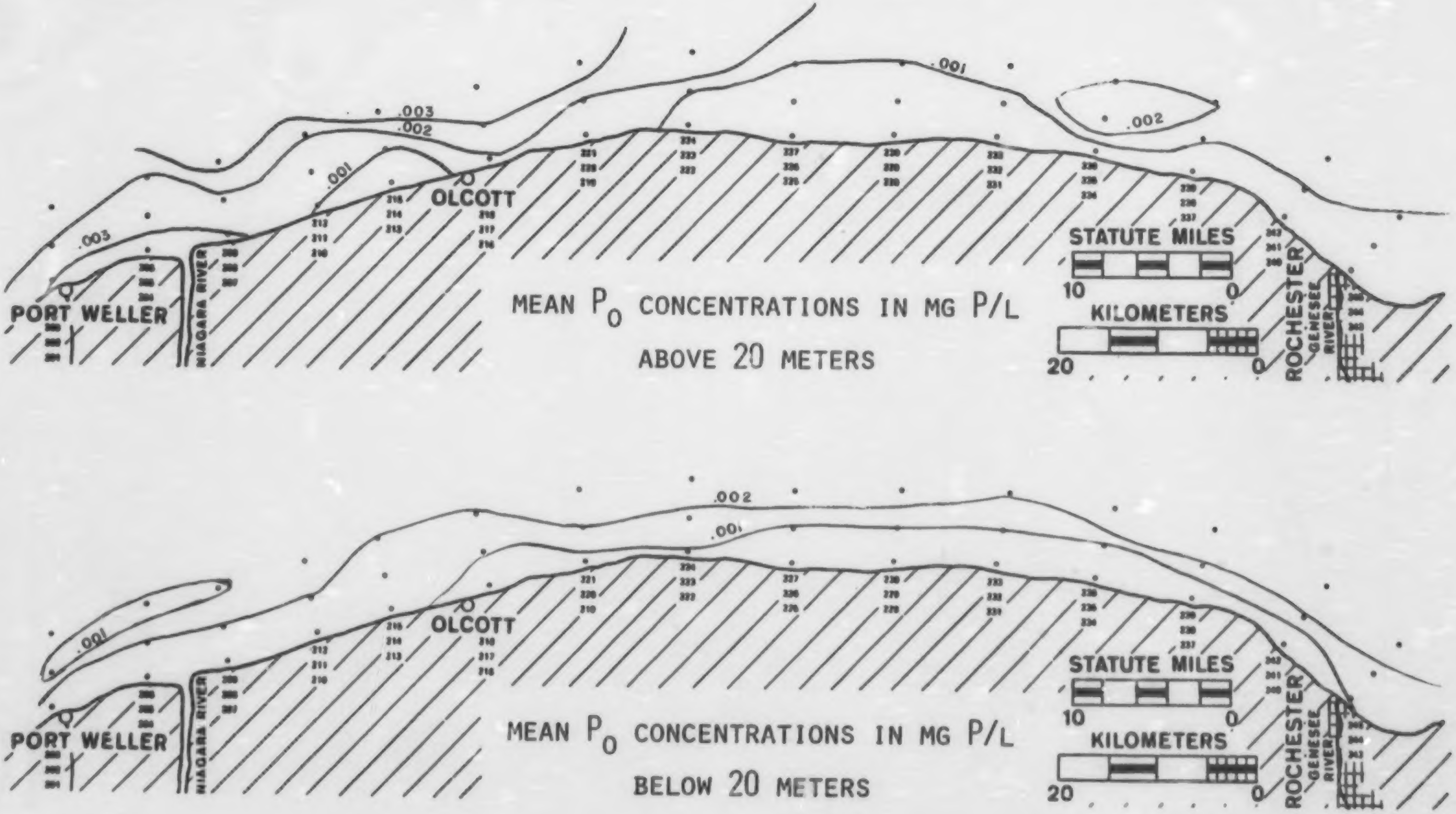

.003
.002
.001
.001
.002
.003
OLCOTT
PORT WELLER
NIAGARA RIVER
STATUTE MILES
10
0
KILOMETERS
20
0
ROCHESTER
GENESEE RIVER
MEAN P_O CONCENTRATIONS IN MG P/L
ABOVE 20 METERS
.002
.001
.001
OLCOTT
PORT WELLER
NIAGARA RIVER
STATUTE MILES
10
0
KILOMETERS
20
0
ROCHESTER
GENESEE RIVER
MEAN P_O CONCENTRATIONS IN MG P/L
BELOW 20 METERS

Figure 54. Mean ortho phosphorus for Lake Ontario during the unithermal period of 1972, cruises I and II

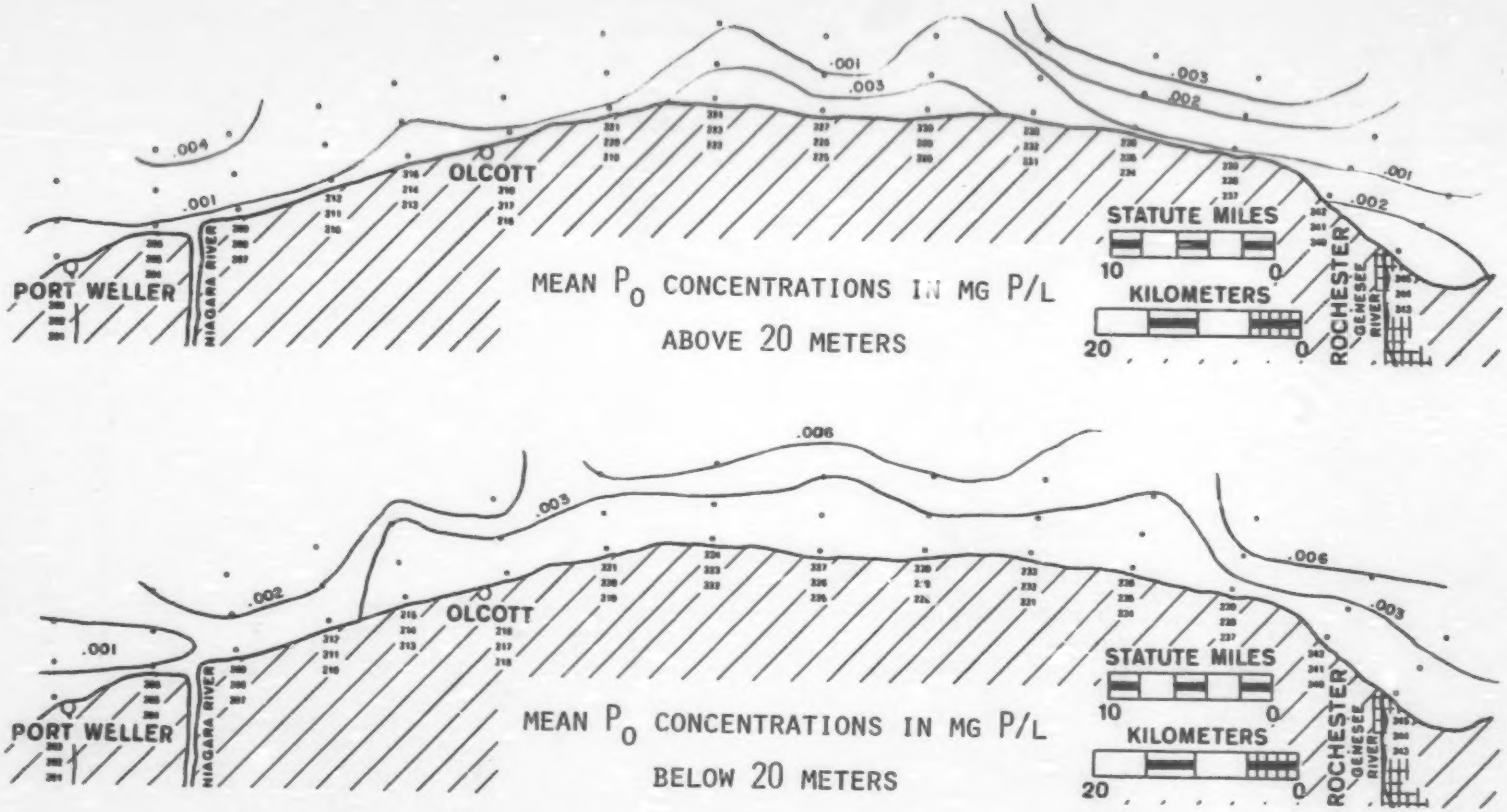
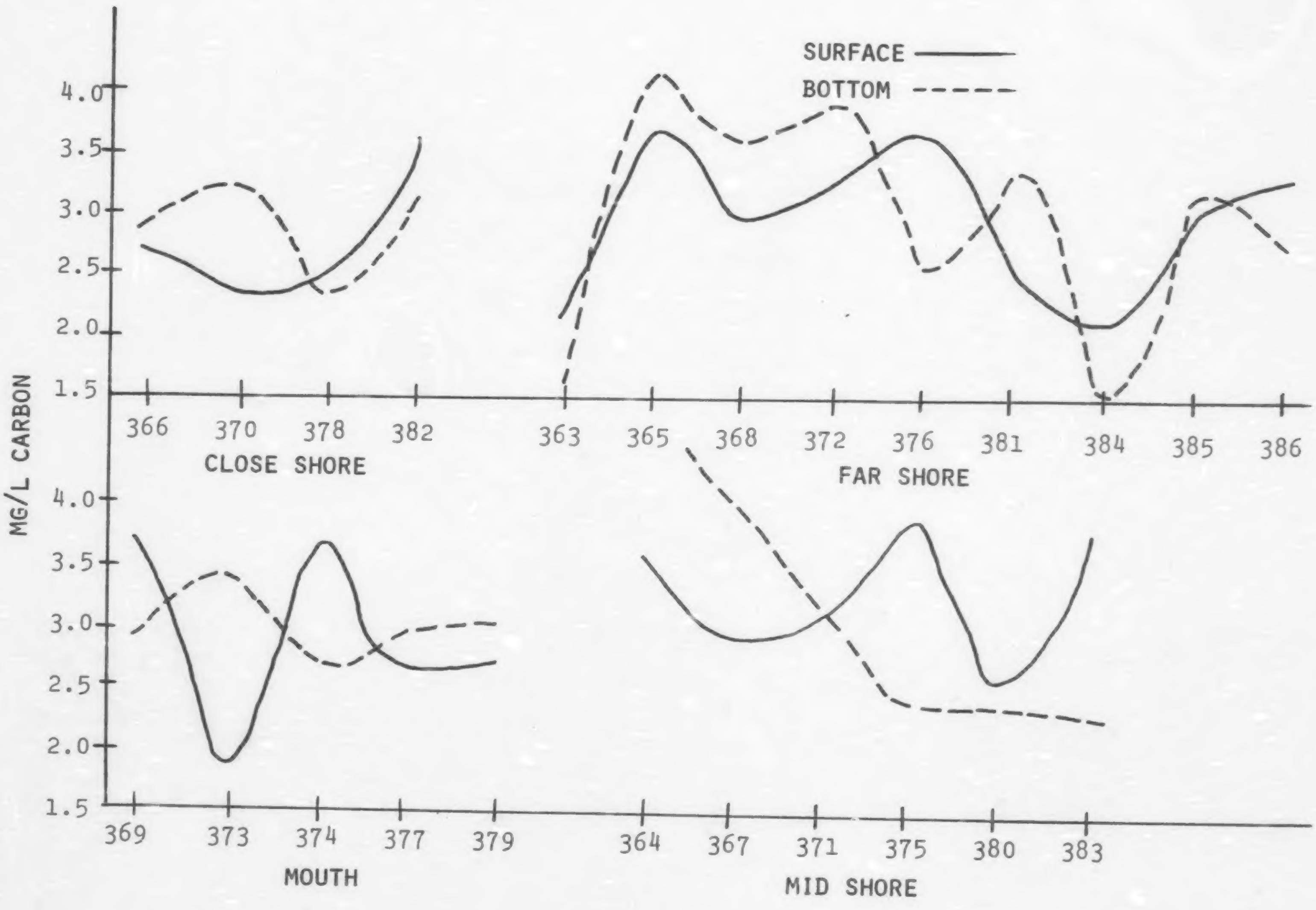

.004
.001
.001
.003
.003
.002
.001
.002
PORT WELLER
NIAGARA RIVER
OLCOTT
ROCHESTER
GENESEE RIVER
STATUTE MILES
10
0
KILOMETERS
20
0
MEAN P_O CONCENTRATIONS IN MG P/L
ABOVE 20 METERS
.006
.003
.002
.001
.006
.003
PORT WELLER
NIAGARA RIVER
OLCOTT
ROCHESTER
GENESEE RIVER
STATUTE MILES
10
0
KILOMETERS
20
0
MEAN P_O CONCENTRATIONS IN MG P/L
BELOW 20 METERS

Figure 55. Mean ortho phosphorus concentrations for Lake Ontario during the stratification period, cruises III - VII



CONTOURS

Figure 56. Mean Niagara River total organic carbon (mg/1)

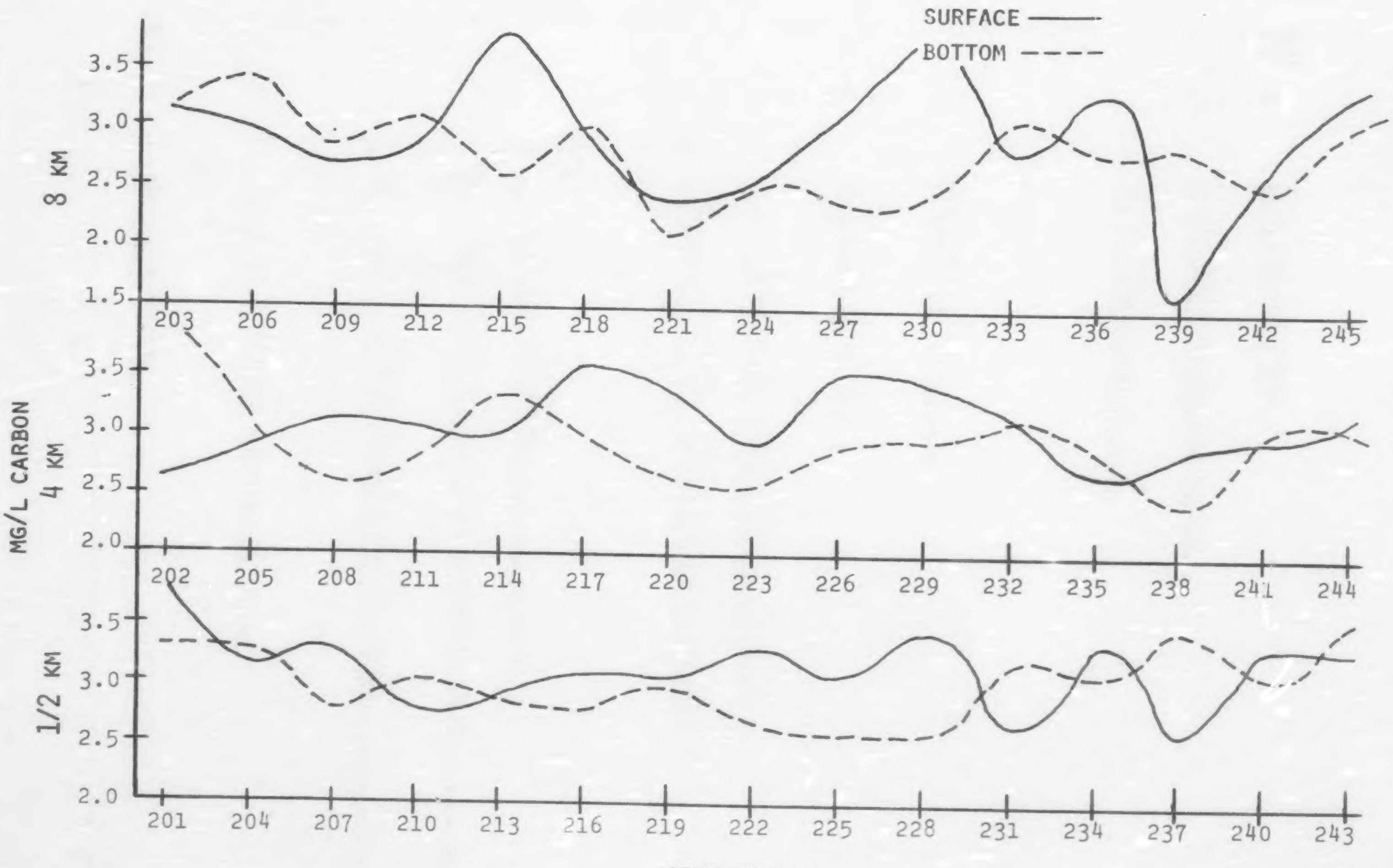


Figure 57. Mean nearshore total organic carbon (mg/l)

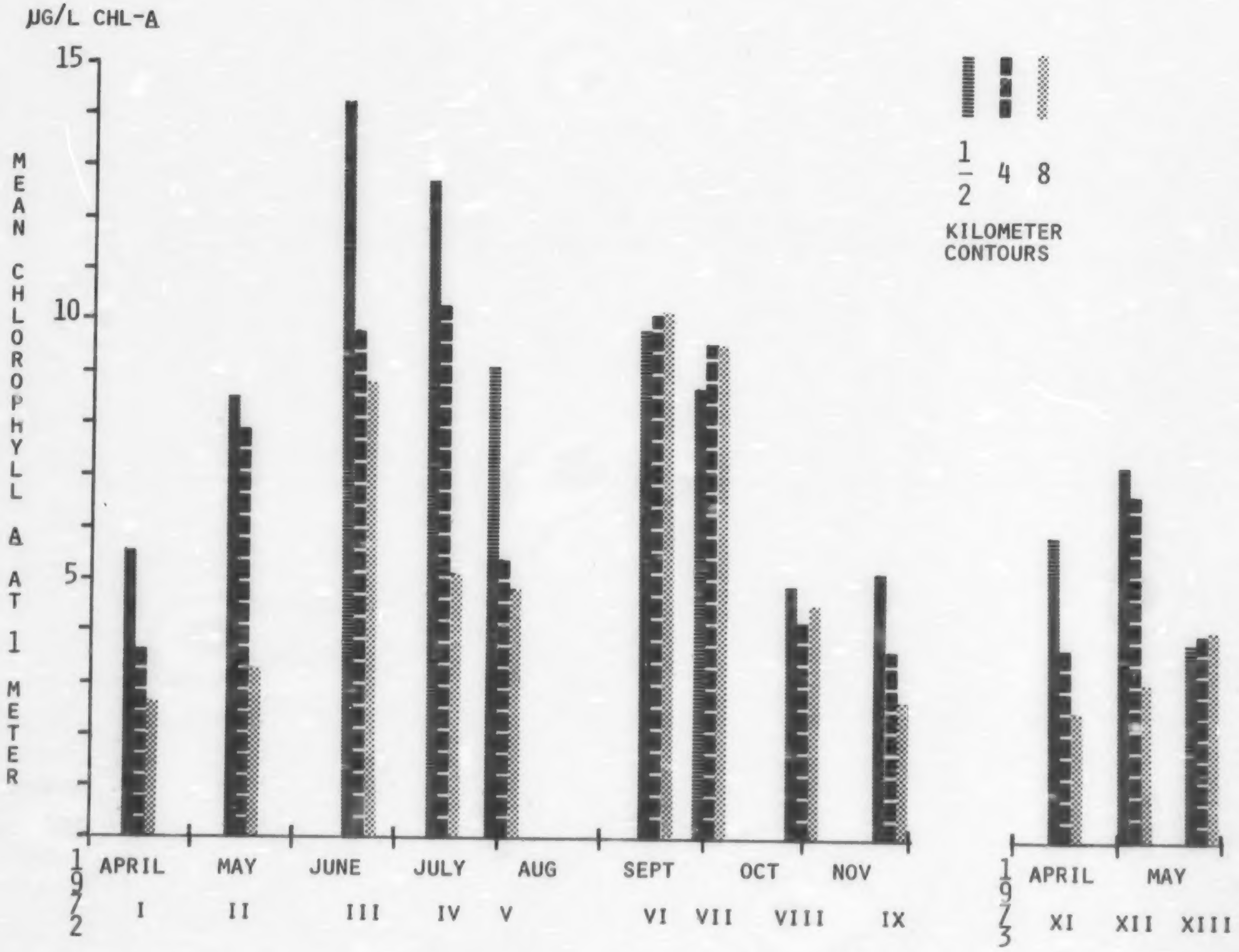


Figure 58. Relationship of mean chl-a values found at 1/2, 4 and 8 kilometer contours within each cruise

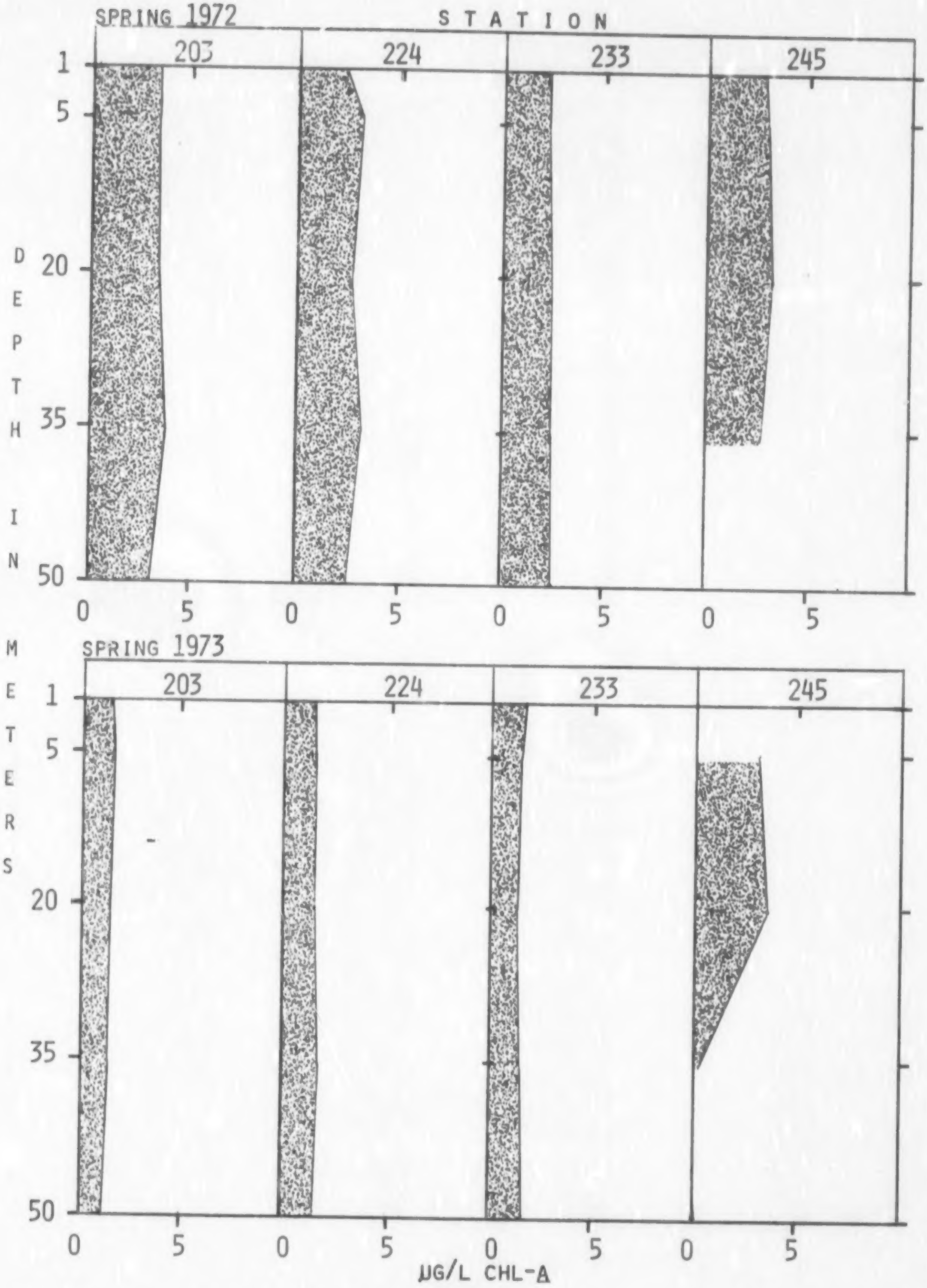


Figure 59. Vertical distribution of chl-a at selected 8 kilometer stations

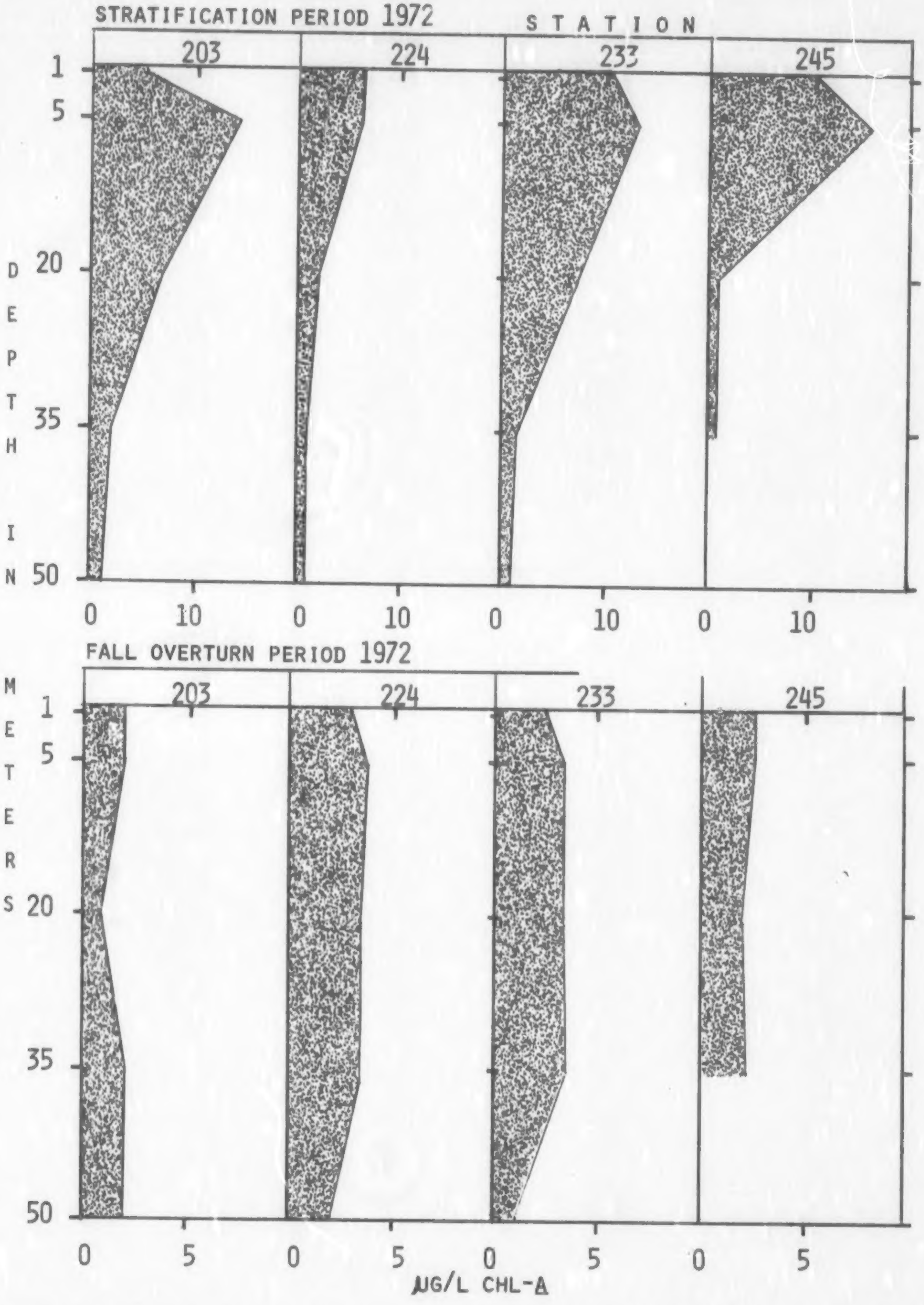


Figure 60. Vertical distribution of chl-a at selected 8 kilometer stations

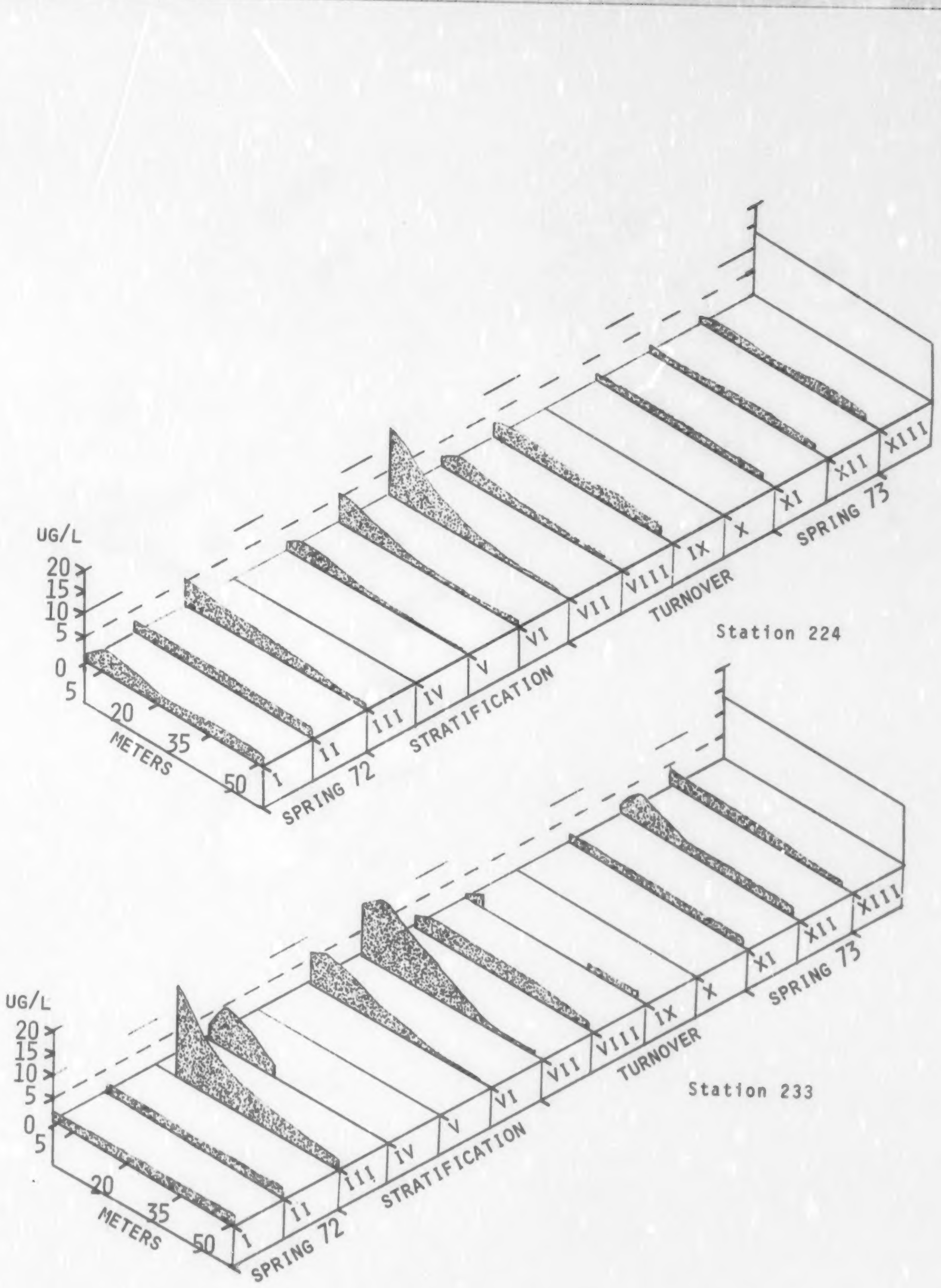


Figure 61. Vertical chl-a development at stations 224 and 233

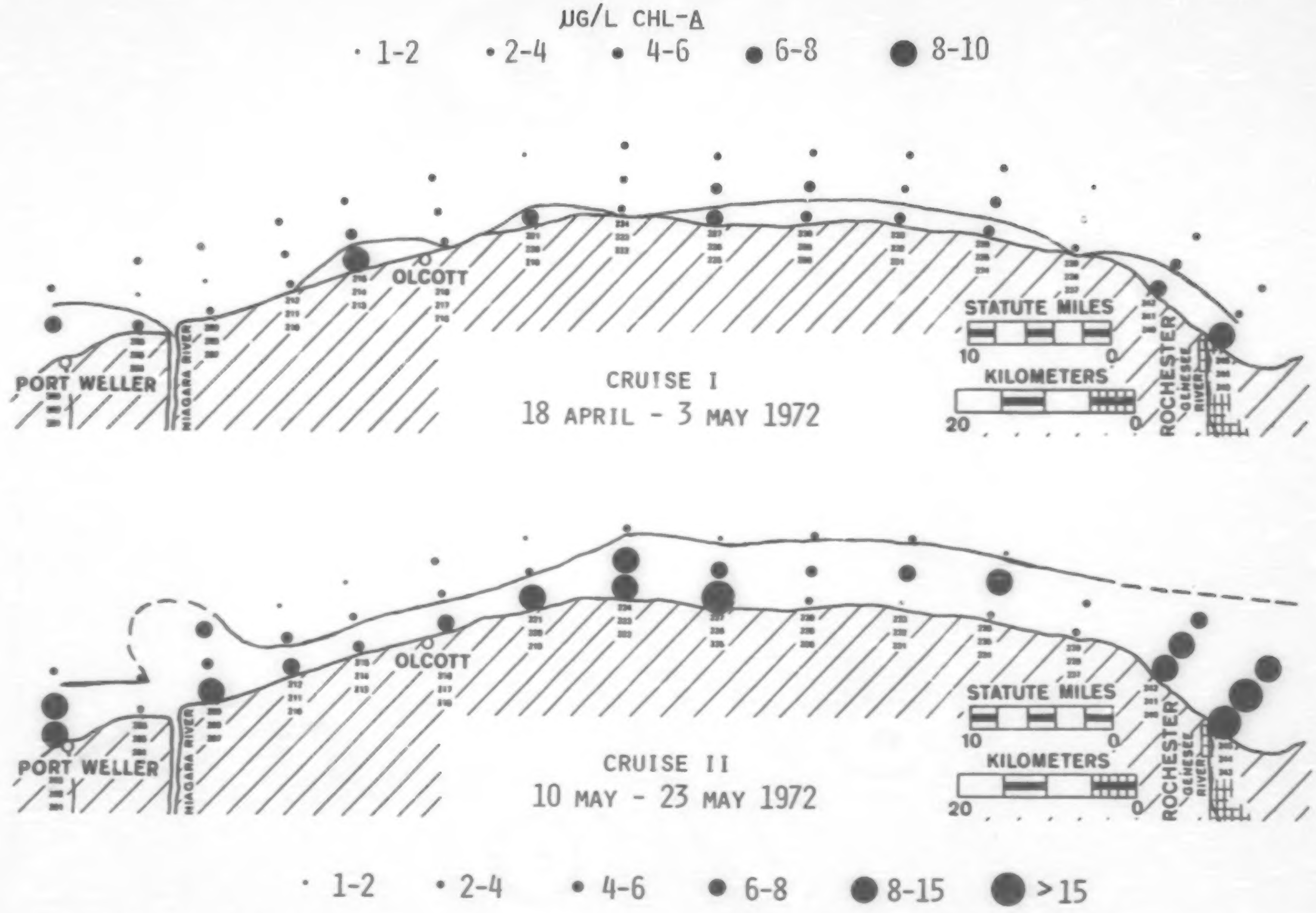

μG/L CHL-A
· 1-2
• 2-4
• 4-6
● 6-8
● 8-10
PORT WELLER
NIAGARA RIVER
OLCOTT
STATUTE MILES
10
0
KILOMETERS
20
0
ROCHESTER
GENESEE RIVER
CRUISE I
18 APRIL - 3 MAY 1972
PORT WELLER
NIAGARA RIVER
OLCOTT
STATUTE MILES
10
0
KILOMETERS
20
0
ROCHESTER
GENESEE RIVER
CRUISE II
10 MAY - 23 MAY 1972
· 1-2
• 2-4
• 4-6
● 6-8
● 8-15
● >15

Figure 62. Thermal bar movement vs. chlorophyll-a development at 1 meter, cruises I and II

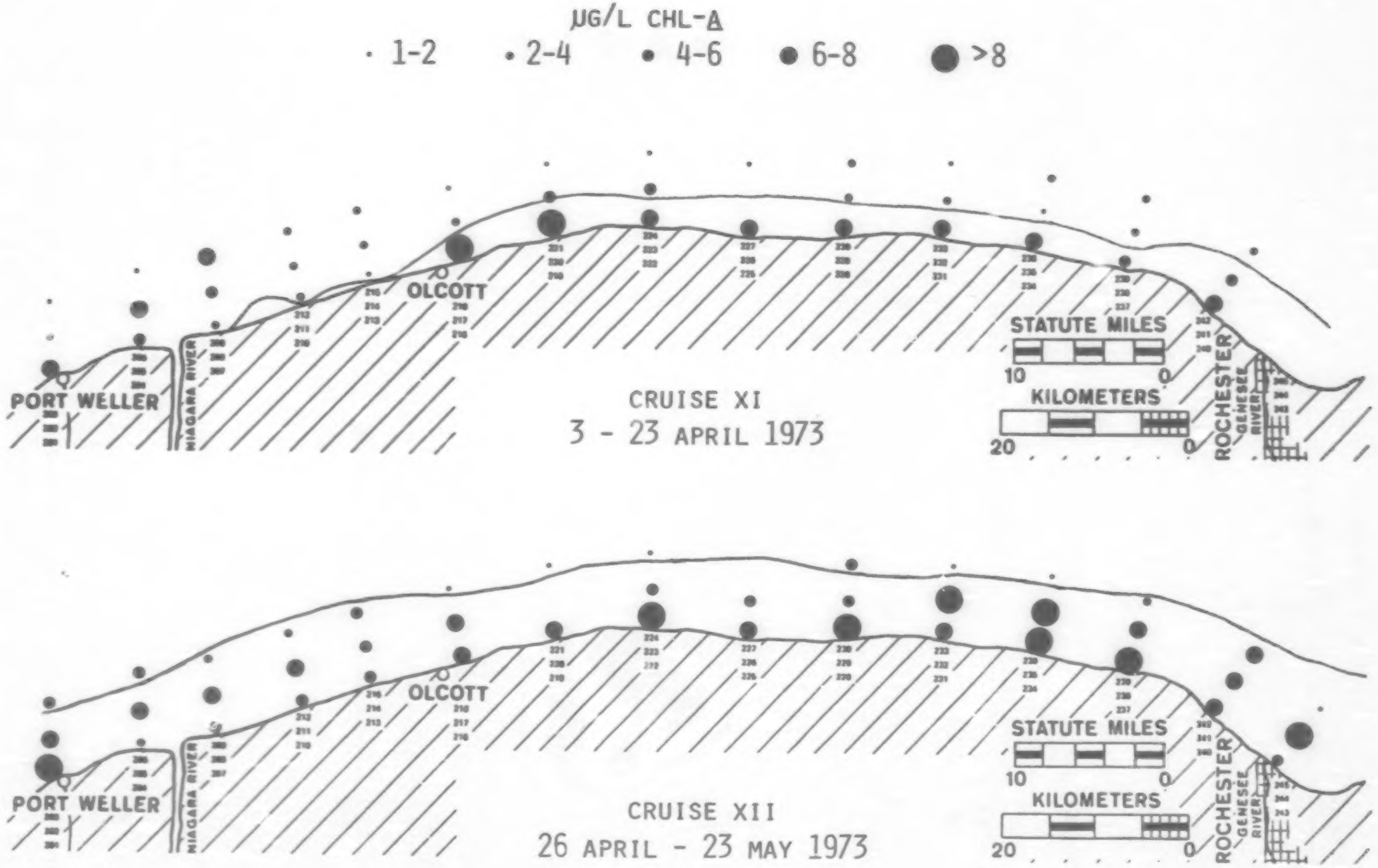

µG/L CHL-A
· 1-2
• 2-4
• 4-6
● 6-8
● >8
PORT WELLER
NIAGARA RIVER
OLCOTT
STATUTE MILES
10
0
KILOMETERS
20
0
ROCHESTER
GENESEE RIVER
CRUISE XI
3 - 23 APRIL 1973
CRUISE XII
26 APRIL - 23 MAY 1973

Figure 63. Thermal bar movement vs. chlorophyll-a development at 1 meter, cruises XI and XII

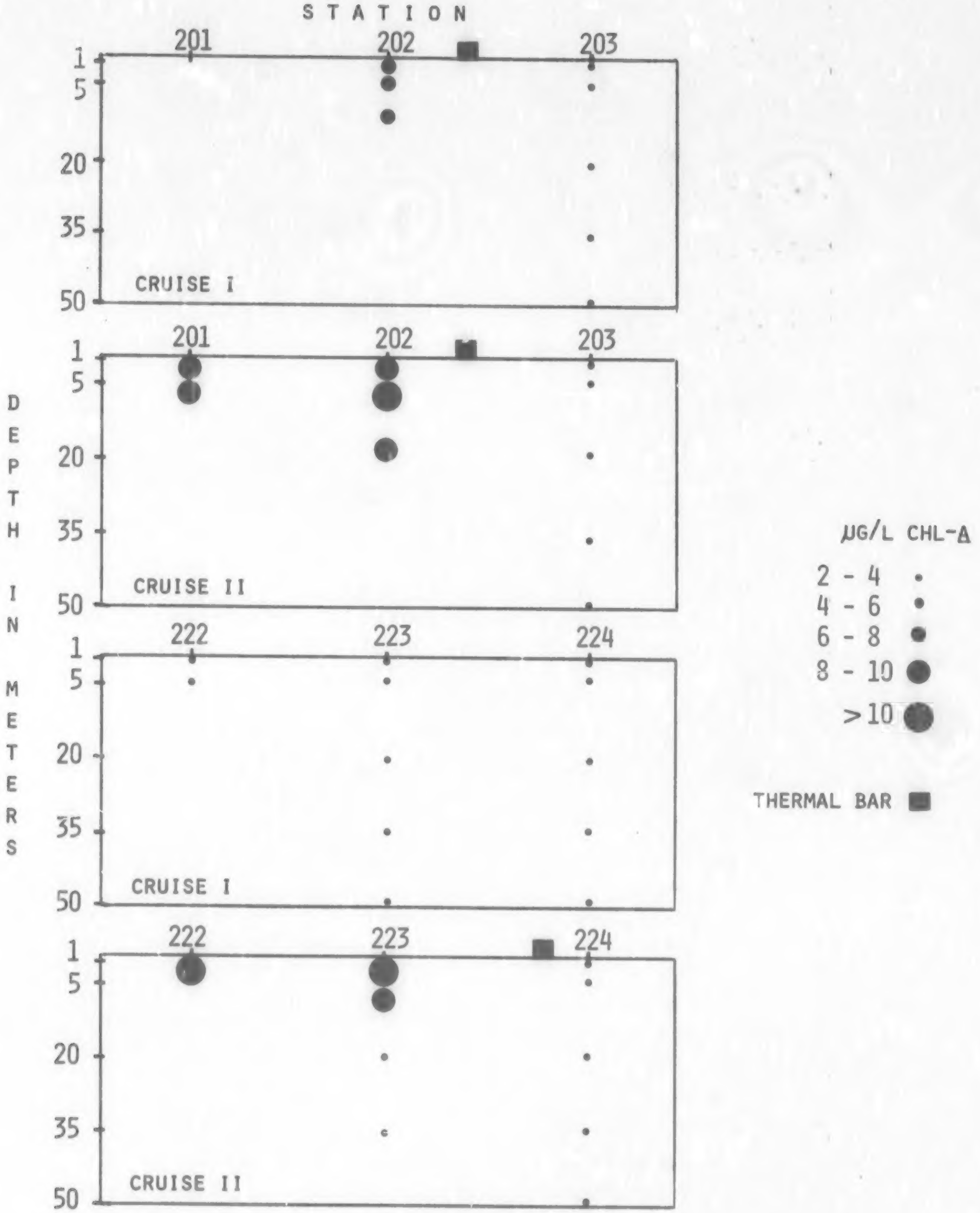


Figure 64. Chlorophyll-a development vs. thermal bar movement

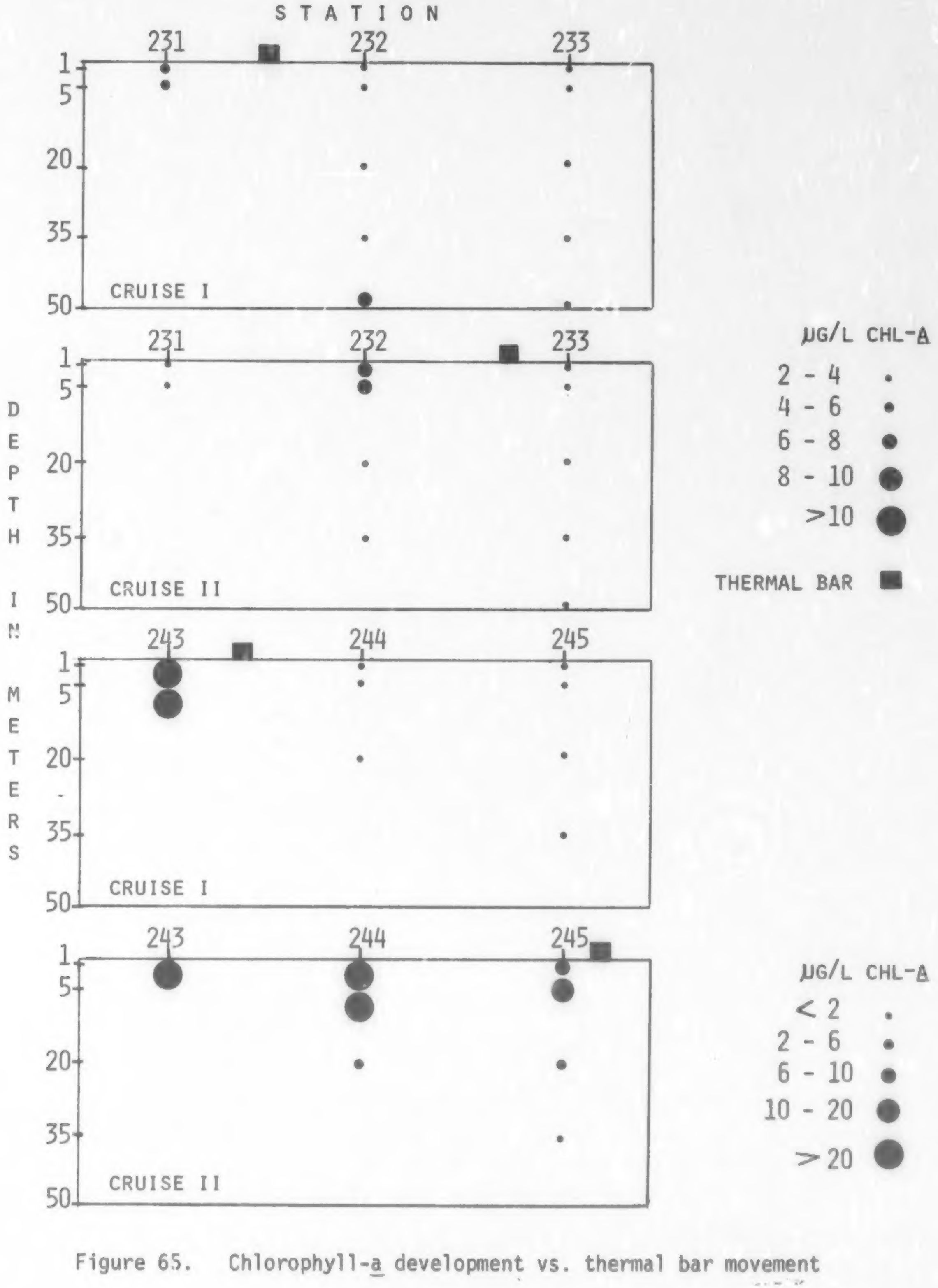


Figure 65. Chlorophyll-a development vs. thermal bar movement

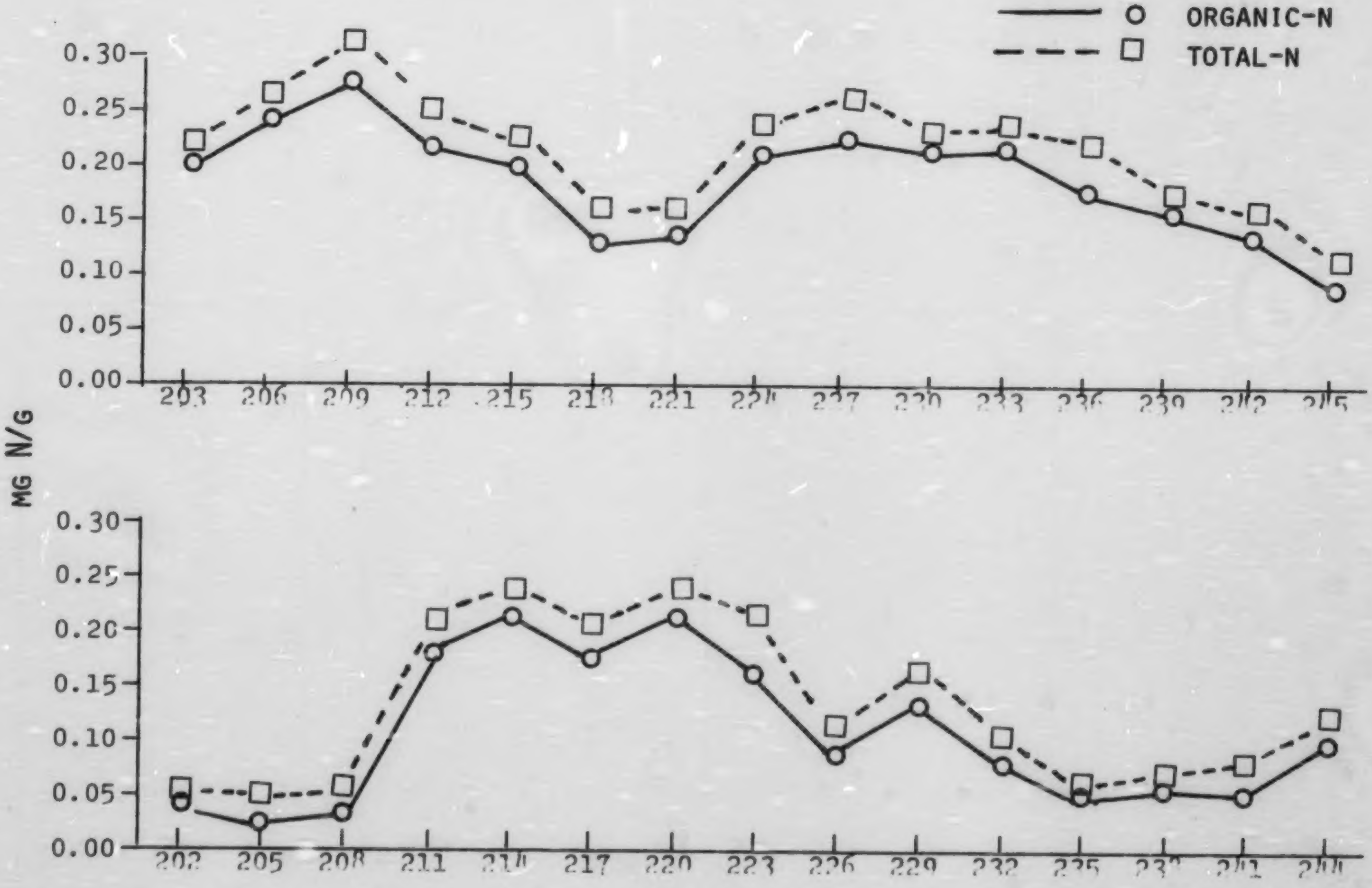


Figure 66. Comparison of organic-N and total-N in Lake Ontario sediments 1972-1973 IFYGL

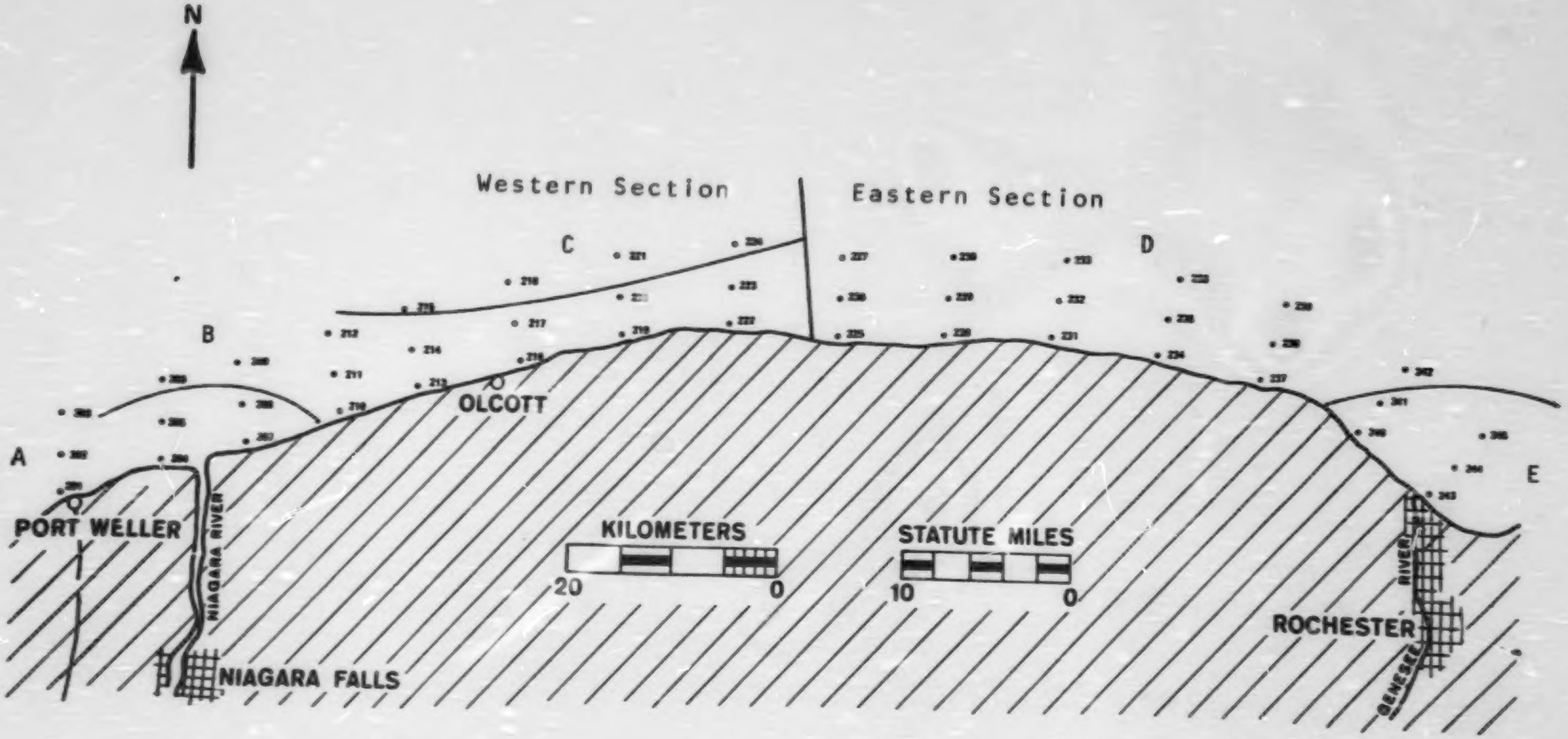

N
Western Section
Eastern Section
A
B
C
D
E
212
214
211
213
210
217
221
219
222
227
231
232
234
237
242
244
PORT WELLER
NIAGARA RIVER
NIAGARA FALLS
OLCOTT
KILOMETERS
20
0
STATUTE MILES
10
0
ROCHESTER
RIVER
GENESEE

Figure 67. Specific areas of sediment metal concentrations

APPENDIX B

TABLES

Table 1. NEARSHORE AND RIVER MOUTH COLLECTION STATIONS

STATION #	LATITUDE	LONGITUDE	DEPTH
LAKE ONTARIO NEARSHORE ZONE			
201	43°13'26"N	79°13'48"W	4.8 m
202	43°15'24"	79°13'48"	23.0
203	43°17'36"	79°13'48"	28.7
204	43°15'48"	79°06'54"	4.7
205	43°17'42"	79°07'36"	14.4
206	43°19'48"	79°07'18"	68.5
207	43°16'48"	79°01'18"	5.2
208	43°18'36"	79°01'48"	12.8
209	43°20'36"	79°02'30"	75.0
210	43°18'18"	78°54'12"	4.0
211	43°20'06"	78°55'00"	46.0
212	43°22'12"	78°55'48"	92.1
213	43°18'48"	78°47'06"	4.5
214	43°21'36"	78°47'48"	51.5
215	43°23'42"	78°48'36"	101.6
216	43°21'18"	78°39'48"	6.5
217	43°23'06"	78°40'36"	61.6
218	43°25'06"	78°41'30"	122.1
219	43°22'24"	78°32'36"	5.4
220	43°24'12"	78°33'00"	68.1
221	43°26'24"	78°33'30"	131.6
222	43°22'48"	78°25'12"	4.0
223	43°24'36"	78°25'24"	50.0
224	43°26'48"	78°25'36"	129.4
225	43°22'36"	78°17'36"	4.6
226	43°24'30"	78°17'36"	45.2
227	43°26'36"	78°17'36"	101.7

Table 1 (continued). NEARSHORE AND RIVER MOUTH COLLECTION STATIONS

STATION #	LATITUDE	LONGITUDE	DEPTH
LAKE ONTARIO NEARSHORE ZONE			
228	43°22'36"N	78°10'18"W	5.0 m
229	43°24'30"	78°10'30"	56.7
230	43°26'36"	78°10'48"	99.2
231	43°22'30"	78°02'48"	4.7
232	43°24'24"	78°02'36"	60.3
233	43°26'30"	78°02'24"	114.2
234	43°21'48"	77°55'30"	4.6
235	43°23'36"	77°54'54"	54.1
236	43°25'42"	77°54'18"	113.2
237	43°20'48"	77°48'12"	5.8
238	43°22'36"	77°47'48"	52.1
239	43°24'48"	77°47'12"	98.3
240	43°18'30"	77°41'18"	4.6
241	43°19'54"	77°39'54"	20.3
242	43°21'36"	77°38'06"	64.6
243	43°15'18"	77°35'30"	4.6
244	43°16'48"	77°33'54"	22.4
245	43°18'42"	77°32'18"	43.5
GENESEE RIVER MOUTH			
351	43°15'53"N	77°35'56"W	8.0
352	43°15'50"	77°35'50"	7.0
353	43°16'11"	77°36'03"	8.9
354	43°16'01"	77°36'39"	8.9
355	43°15'51"	77°35'17"	9.3
356	43°16'39"	77°36'27"	13.3

Table 1 (continued). NEARSHORE AND RIVER MOUTH COLLECTION STATIONS

STATION #	LATITUDE	LONGITUDE	DEPTH
GENESEE RIVER MOUTH			
357	43°16'29"N	77°36'07"W	12.0 m
358	43°16'18"	77°35'44"	10.9
359	43°16'08"	77°35'21"	10.8
360	43°15'57"	77°34'59"	11.3
361	43°15'47"	77°34'37"	12.3
362	43°16'26"	77°35'28"	13.8
NIAGARA RIVER MOUTH			
363	43°16'00"	79°05'24"	7.0
364	43°15'55"	79°05'06"	4.0
365	43°16'10"	79°05'08"	10.2
366	43°15'50"	79°04'45"	2.7
367	43°16'06"	79°04'50"	12.3
368	43°16'20"	79°04'50"	5.7
369	43°15'40"	79°04'26"	3.0
370	43°16'00"	79°04'24"	16.3
371	43°16'15"	79°04'35"	6.2
372	43°16'30"	79°04'10"	8.2
373	43°15'45"	79°04'15"	19.5
374	43°15'46"	79°04'10"	24.2
375	43°16'20"	79°04'10"	4.8
376	43°16'35"	79°04'08"	7.8
377	43°15'46"	79°04'05"	23.2
378	43°16'05"	79°04'05"	5.0
379	43°15'47"	79°03'56"	21.5
380	43°16'15"	79°03'50"	4.0

Table 1 (continued). NEARSHORE AND RIVER MOUTH COLLECTION STATIONS

STATION #	LATITUDE	LONGITUDE	DEPTH
NIAGARA RIVER MOUTH			
381	43°16'35"N	79°03'45"W	6.5 m
382	43°15'55"	79°03'40"	3.0
383	43°16'08"	79°03'25"	4.2
384	43°16'30"	79°03'23"	5.5
385	43°16'20"	79°03'10"	4.5
386	43°16'10"	79°02'50"	2.8

Table 2. CLADOPHORA COLLECTION TRANSECTS

STATION #	LATITUDE	LONGITUDE
207	43°16'18"N	79°01'18"W
216	43°20'48"	79°39'48"
222	43°22'18"	79°25'12"
228	43°22'06"	79°10'18"
237	43°20'18"	77°48'12"

Table 3. 1972-1973 IFYGL COLLECTION DATES

CRUISE	JULIAN DATES	GREGORIAN DATES
LAKE ONTARIO NEARSHORE ZONE		
I	109-124	18 April - 3 May 1972
II	131-144	10 May - 23 May 1972
III	171-180	19 June - 28 June 1972
IV	194-203	12 July - 21 July 1972
V	207-215	25 July - 2 Aug. 1972
VI	249-257	5 Sept. - 13 Sept. 1972
VII	265-278	21 Sept. - 4 Oct. 1972
VIII	285-307	11 Oct. - 2 Nov. 1972
IX	311-327	6 Nov. - 22 Nov. 1972
X	346-349	11 Dec. - 14 Dec. 1972
XI	092-115	3 April - 25 April 1973
XII	116-136	26 April - 16 May 1973
XIII	143-151	23 May - 31 May 1973
NIAGARA RIVER MOUTH		
I	150-157	29 May - 6 June 1972
II	159-161	8 June - 9 June 1972
III	164-168	12 June - 16 June 1972
IV	234-239	21 Aug. - 26 Aug. 1972
V	241-244	28 Aug. - 31 Aug. 1972
VI	340-347	5 Dec. - 12 Dec. 1972
VII	138-142	18 May - 22 May 1973
CLADOPHORA		
I	172-180	20 June - 28 June 1972
II	193-202	11 July - 20 July 1972
III	209-214	27 July - 1 Aug. 1972

Table 3 (continued). 1972-1973 IFYGL COLLECTION DATES

CRUISE	JULIAN DATES	GREGORIAN DATES
CLADOPHORA		
IV	221-230	8 Aug. - 17 Aug. 1972
V	292-301	18 Oct. - 27 Oct. 1972
VI	122-135	2 May - 15 May 1973
GENESEE RIVER MOUTH		
I	151-153	30 May - 1 June 1972
II	156-157	4 June - 5 June 1972
III	157-158	5 June - 6 June 1972
IV	158-159	6 June - 7 June 1972
V	164-165	12 June - 13 June 1972
VI	235-237	22 Aug. - 24 Aug. 1972
VII	241-242	28 Aug. - 29 Aug. 1972
VIII	332-333	27 Nov. - 28 Nov. 1972
IX	136	16 May 1973

Table 4. 1972-1973 IFYGL SEDIMENT SAMPLING DATES

CRUISE	JULIAN DATES	GREGORIAN DATES
LAKE ONTARIO NEARSHORE ZONE		
I	109-124	18 April - 3 May 1972
III	171-180	19 June - 28 June 1972
VI	249-257	5 Sept. - 13 Sept. 1972
IX	311-327	6 Nov. - 22 Nov. 1972
XI	092-115	3 April - 25 April 1973
NIAGARA RIVER MOUTH		
I	150-157	29 May - 5 June 1972
III	164-168	12 June - 16 June 1972
IV	234-239	21 Aug. - 26 Aug. 1972
VI	340-347	5 Dec. - 12 Dec. 1972
VII	138-142	18 May - 22 May 1973
GENESEE RIVER MOUTH		
I	151-153	30 May - 1 June 1972
V	164-165	12 June - 13 June 1972
VI	235-236	22 Aug. - 24 Aug. 1972
VIII	332-333	27 Nov. - 28 Nov. 1972
IX	136	16 May 1973

Table 5. THERMAL PROFILE (°C) FOR STATION 232

CRUISE	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
	1972										1973		
DEPTH	MAY 1	MAY 22	JUNE 27	JULY 20	AUG 1	SEPT 12	OCT 3	NOV 1	NOV 21	DEC –	APR 24	MAY 15	MAY 30
Surface	2.7	8.5	14.0	-	-	19.2	15.5	8.9	6.9	N	3.0	7.0	5.4
1/2 m	2.7	8.0	14.0	-	-	19.2	15.3	8.9	6.9	O	3.0	7.1	5.3
1	2.7	5.5	14.0	22.5	21.5	19.2	15.2	8.9	6.9		3.0	7.0	5.3
2	2.7	5.0	14.0	-	-	19.2	15.2	8.9	6.9	D	3.0	7.0	5.0
5	2.6	4.0	12.8	21.0	21.0	19.2	15.0	8.9	6.9	A	3.0	7.0	4.4
15	2.6	3.8	6.1	-	12.5	19.0	14.7	8.5	7.0	T	3.0	6.1	4.1
25	2.5	3.5	4.4	9.0	-	7.5	13.5	6.8	7.0	A	3.0	5.8	4.0
35	2.7	3.5	4.0	6.0	8.0	5.5	10.5	5.0	7.0		3.0	5.4	3.9
45	3.0	3.5	4.0	-	-	4.6	9.0	4.5	6.9		3.0	5.0	3.7
55	3.9	3.2	-	6.0	5.5	4.0	8.2	4.5	6.9		3.6	5.0	-

Table 6. OXYGEN PROFILES - % SATURATION FOR STATIONS 231, 232, 233

CRUISE		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
		1972										1973		
STATION	DEPTH	MAY 1	MAY 22	JUNE 27	JULY 20	AUG 1	SEPT 12	OCT 3	NOV 1	NOV 21	DEC -	APR 24	MAY 15	MAY 30
231	1 m	118	128	125	130	112	104	110	95	99	N	98	102	105
											O			
232	1 m	104	117	150	128	118	105	100	91	95	L	95	102	102
	25	-	115	102	117	-	-	-	88	95	A	-	99	98
	35	111	115	-	-	108	-	-	-	-	T	94	-	-
	45	115	-	100	-	-	-	-	-	-	A	-	-	-
	55	119	112	-	118	100	-	72	-	96		-	99	-
	65	121	-	-	-	-	91	-	90	-		96	-	97
233	1 m	105	104	155	140	122	105	103	94	94	N	95	96	N
	45	117	109	108	122	109	101	87	-	-	O	94	94	O
	85	117	111	101	126	108	-	-	-	-	D	-	-	D
	115	-	-	-	-	-	83	90	92	96	A	93	95	A
											T			T
											A			A

Table 7. PHYTOPLANKTON SPECIES ENCOUNTERED IN LAKE ONTARIO 1972-1973 IFYGL

CRUISE	I	II	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
CHLOROPHYTA												
Ankistrodesmus falcatus (Corda) Ralfs	X	X		X	X					X	X	X
A. falcatus var. *acicularis* A. Braun	X	X									X	X
Closteriopsis longessima Lemmerman			X		X	X	X		X			
Closterium parvulum var. *angustatum* (West)					X	X	X					
Coelastrum microperum Naegeli					X	X	X					
C. reticulatum (Dang) Senn					X	X	X					
Cosmarium formosulum Hoffman					X							
Filament #2			X	X	X							
Moegeotia sp.					X							
Oedogonium sp.					X							
Oocystis bergei Snow				X	X	X	X					
Pediastrum simplex var. *duodenarium* (Bailey) Rabenhorst					X							
Scenedesmus bijuga (Turp) Langerheim	X	X			X							
S. quardricanda (Turp) de Brebisson			X	X	X							
Schroederia setigera (Schroed) Lemmerman				X	X	X	X					
Staurastrum paradoxum Meyer					X	X						
S. sp. #2					X							
Tetraedron minimum (A. Braun) Hansgirg					X	X	X					

Table 7 (continued). PHYTOPLANKTON SPECIES ENCOUNTERED IN LAKE ONTARIO, 1972-1973 IFYGL

CRUISE	I	II	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
CHRYSOPHYTA												
BACILLARIOPHYCEAE												
Asterionella formosa Hassall	X	X	X	X	X	X	X	X	X	X	X	X
Diatoma elongatum (Lyngbye)	X	X	X	X	X	X	X	X		X	X	X
D. elongatum var. *tenuis* Agardh	X											
Fragelaria capucina Desmazieres	X	X				X		X				
F. crotenensis Kitton	X	X			X	X		X				
Melosira binderana Kuetzing	X	X	X	X	X	X		X			X	X
M. islandica ssp. *helvetica* O. Muller	X	X	X	X	X	X		X	X	X	X	X
Nitzschia acicularis Kuetzing										X	X	
N. palea Kuetzing										X		
N. vermicularis Kuetzing	X		X		X			X	X	X	X	
Stephanodiscus astrae (Ehrenberg) Grunow										X		
S. hantzschii Grunow	X	X								X	X	
S. Niagarae Ehrenberg	X	X						X	X			
S. tenuis Hustedt	X	X					X	X	X	X	X	X
Surirella angustata Kuetzing	X	X					X	X	X	X	X	X
Synedra acus Kuetzing								X	X			
S. ulna (Nitzsch) Ehrenberg				X								
Tabellaria fenestrata Lyngbye	X	X	X	X		X	X	X		X	X	X
CHRYSOPHYCEAE												
Chrysochromulina parva Lackey	X	X	X	X								
Dinobryon sertularia Ehrenberg			X	X								

Table 7 (continued). PHYTOPLANKTON SPECIES ENCOUNTERED IN LAKE ONTARIO, 1972-1973 IFYGL

CRUISE	I	II	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
CRYPTOPHYTA												
Crytomonas erosa Ehrenberg	X	X	X	X	X	X	X	X	X	X	X	X
Crypto #2				X	X	X	X	X	X		X	X
Flagellate E			X	X		X	X					
Katablepharis ovalis Skuja			X	X	X	X	X					
Rhodomonas minuta Skuja	X	X	X	X	X	X	X	X	X	X	X	X
R. minuta var. *nannoplanktica* Skuja			X	X	X							
CYANOPHYTA												
Anabaena sp.												
Aphanozominon flos-aquae (L.) Ralfs					X	X	X	X				
Coelosphaerium naegelianum Unger												
Gomphosphaeria aponina Kuetzing												
Meresmopedia sp.					X							
Oscillatoria limnetica Lemmerman	X	X	X	X	X							X
PYRRHOPHYTA												
DINOPHYCEAE												
Ceratium herundenella O. Muller					X	X						
Dinoflagellate #1	X	X										

Table 7 (continued). PHYTOPLANKTON SPECIES ENCOUNTERED IN LAKE ONTARIO, 1972-1973 IFYGL

CRUISE	I	II	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
DINOPHYCEAE												
Dinoflagellate #2	X	X		X	X			X	X	X	X	X
Gymnodinium helveticum Penard	X	X			X	X	X	X			X	X
Peridinium aciculeferum (Lemmerman) Lindem	X	X										X
P. sp.					X	X						

Table 8. PHYTOPLANKTON CELL VOLUMES ENCOUNTERED IN LAKE ONTARIO 1972-1973 IFYGL

SPECIES	CELL VOLUME (μ^3)
Ankistrodesmus falcatus	22
Asterioncila formosa	449
Ceratium hirundinella	120,000
Chrysochromulina parva	122
Cryptomonus erosa	2,369
Diatoma elongatum	1,469
Fragilaria capucina	682
F. crotonensis	1,285
Gymnodinium helveticum	10,343
Melosira binderana	886
M. islandica ssp. helvetica	2,901
Peridinium aciculiferum	6,585
Peridinium sp.	10,806
Rhodomonus minuta	220
Scenedesmus bijuga	24
Staurastrum paradoxum	40,400
Stephanodiscus hantzschii	289
S. Tenuis	2,679
Surirella angustata	9,358
Tabellaria fenestrata	3,152

Table 9. SEASONAL DISTRIBUTION OF TOTAL ZOOPLANKTON CONCENTRATIONS (organisms/m³)

CRUISE	I	II	III	IV	V	VI	VII	VIII	IX	X
	1972									
LOCATION										
1/2 km	3759	4569	14549	25997	51904	144266	145713	68827	16877	5829
4 km	2924	3932	12780	5207	10986	28134	24984	35920	14072	17345
8 km	1050	1741	4569	2779	6305	14435	14822	27782	6203	7624
entire area	2578	3414	10633	11328	23065	62238	61840	44176	12384	10266

CRUISE	XI	XII	XIII
	1973		
LOCATION			
1/2 km	16705	28610	4917
4 km	3650	14602	3965
8 km	1919	3722	1308
entire area	7425	15645	3397

Table 10. MEAN PERCENTAGE OF CRUSTACEAN ZOOPLANKTON

1/2 KM

TAXON	SPRING 1972	SPRING 1973	ENTIRE 1972	1972 - 1973*
Nauplii	58	80	25	31
Calanoids	3	1	1	1
Cyclopoids	36	19	25	24
Cladocerans	2	1	49	44

4 KM

TAXON	SPRING 1972	SPRING 1973	ENTIRE 1972	1972 - 1973*
Nauplii	52	78	41	45
Calanoids	3	2	2	2
Cyclopoids	43	20	38	34
Cladocerans	3	1	19	18

8 KM

TAXON	SPRING 1972	SPRING 1973	ENTIRE 1972	1972 - 1973*
Nauplii	48	64	40	42
Calanoids	8	6	2	3
Cyclopoids	42	30	42	41
Cladocerans	1	1	16	14

* ENTIRE SAMPLING PERIOD (APRIL-DECEMBER 1972; APRIL AND MAY, 1973)

Table 11. SEASONAL ABUNDANCE OF CRUSTACEAN ZOOPLANKTON (% OF ZOOPLANKTON)

CRUISE	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
	1972										1973		
TAXON													
1/2 KM													
Nauplii	52	63	35	55	23	25	21	20	20	46	70	87	69
Calanoids	5	1	1	2	1	1	1	2	4	5	1	1	2
Cyclopoids	40	32	33	16	11	17	19	50	65	40	29	12	28
Cladocerans	3	2	30	26	64	56	59	29	10	9	1	1	1
4 KM													
Nauplii	46	55	20	39	31	38	50	38	37	57	61	83	77
Calanoids	3	3	1	2	1	1	2	1	4	6	3	1	4
Cyclopoids	47	39	66	23	20	28	27	42	52	31	36	16	19
Cladocerans	4	3	13	36	49	34	21	19	6	6	1	1	1
8 KM													
Nauplii	39	54	18	32	47	46	54	38	34	25	45	74	65
Calanoids	10	6	3	3	1	1	2	1	6	5	10	4	6
Cyclopoids	49	39	58	39	28	32	27	45	57	68	46	22	28
Cladocerans	2	1	22	26	24	21	18	15	3	2	1	1	1

Table 12. MEAN CONCENTRATIONS OF CRUSTACEAN ZOOPLANKTON (numbers/m³)

	CRUISE		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
			1972										1973		
	IDENTIFICATION GROUP	KM													
CLADOCERA	*Alona* spp.	1/2	-	9	-	60	18	-	7	-	-	-	2	2	1
		4	-	+	-	-	1	-	4	-	4	-	-	+	-
		8	-	-	-	-	-	-	-	-	2	-	-	-	-
	Bosminids With Mucro	1/2	79	80	3310	6473	32469	64027	53358	10860	518	93	55	36	55
		4	83	89	1638	1842	4976	5716	1459	3639	147	267	5	23	12
		8	15	16	972	708	1327	1543	577	1934	75	33	2	1	7
	Camptocercus rectirostris	1/2	-	-	4	256	41	-	20	-	-	-	-	-	-
		4	-	-	-	-	2	-	-	-	-	-	-	-	-
	Ceriodaphnia lacustris	1/2	-	-	-	-	229	10875	9180	1395	10	-	-	-	-
		4	-	-	-	1	29	1157	928	550	-	-	-	-	-
		8	-	-	-	-	1	505	543	682	-	-	-	-	-
	Chydorus sphaericus	1/2	7	7	18	16	63	-	39	44	-	-	-	2	-
		4	+	+	-	12	2	-	-	2	2	-	-	+	-
		8	-	+	-	-	-	-	-	-	-	-	-	-	-
	Daphnia galeata mendotae	1/2	-	-	-	-	5	89	218	203	77	70	-	-	-
		4	-	-	-	1	-	-	73	17	90	383	1	-	-
		8	-	-	-	-	4	3	3	11	1	-	-	-	-
	D. longiremis	1/2	-	-	-	5	3	-	-	20	-	-	2	2	-
		4	-	-	-	1	1	-	-	1	-	-	-	1	-
	D. retrocurva	1/2	-	-	-	10	553	5836	23292	6354	724	11	5	-	-
		4	-	-	-	4	313	2600	2784	2461	157	43	3	4	-
		8	-	-	4	4	189	954	1528	1279	35	-	-	-	1

Table 12 (continued). MEAN CONCENTRATIONS OF CRUSTACEAN ZOOPLANKTON (numbers/m^3)

	CRUISE		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
			-------------------------1972									------------------------------	------1973		------
	IDENTIFICATION GROUP	KM													
CLADOCERA	*Diaphanosoma leuchtenbergianum*	1/2	-	-	-	-	3	36	9	-	-	-	-	-	-
		4	-	-	-	-	-	-	4	-	-	-	-	-	-
		8	-	-	-	-	-	-	3	-	-	-	-	-	-
	Eubcsmina ccregoni	1/2	9	4	1016	22	23	54	139	834	405	349	5	6	1
		4	16	10	10	17	14	17	81	259	436	369	2	3	6
		8	2	1	20	7	1	31	13	265	90	130	-	1	-
	Eurycercus lamellatus	1/2	-	-	-	-	5	-	-	-	-	-	-	-	-
	Holopedium gibberum	1/2	-	-	-	-	-	-	-	90	-	-	-	-	-
		4	-	-	-	-	-	7	-	16	6	-	-	1	-
		8	-	-	-	-	-	4	-	-	-	-	-	-	-
	Leptodora kindtii	1/2	-	-	-	-	18	30	108	-	-	-	-		
		4	-	-	-	-	-	-	35	8	2	-	-	-	-
		8	-	-	-	-	-	4	32	12	-	-	-	-	-
	Macrcthrix sp.	4	-	-	-	-	-	-	-	8	8	-	-	-	-
	Pclyphemus pediculus	1/2	-	-	-	-	7	-	-	-	-	-	-	-	-
	Copepod Nauplii	1/2	1962	2862	5159	14372	12032	36238	30371	13540	3450	2655	11618	24996	3376
		4	1357	2180	2601	2027	3387	10653	12459	13583	5269	9906	2226	12081	3034
		8	411	939	800	895	2952	6595	7944	10587	2088	1933	854	2753	851
	Immature Calanoid Copepodids	1/2	116	49	81	530	723	1879	702	1185	185	116	62	76	95
		4	64	72	77	71	54	219	280	293	366	275	78	140	142
		8	76	88	92	62	48	83	138	252	165	132	132	106	66

Table 12 (continued). MEAN CONCENTRATIONS OF CRUSTACEAN ZOOPLANKTON (numbers/m³)

	CRUISE		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
			1972										1973		
	IDENTIFICATION GROUP	KM													
	Diaptomus ashlandi	1/2	2	-	-	-	-	-	-	-	-	-	-	-	-
	D. minutus	1/2	51	9	-	26	8	91	3	-	34	11	16	17	3
		4	9	11	6	12	5	11	18	33	26	23	12	16	5
		8	27	16	7	6	16	20	6	11	18	36	17	10	3
	D. oregonensis	1/2	3	2	-	-	-	-	54	72	213	173	53	7	2
		4	4	13	-	3	-	110	92	17	165	639	16	7	-
		8	2	4	-	1	3	30	33	13	36	43	12	3	2
CALANOIDA	*D. pallidus*	1/2	-	-	-	-	-	-	3	-	-	-	-	-	-
		4	-	-	-	-	-	-	-	-	2	-	-	-	-
	D. sicilis	1/2	10	-	-	-	-	-	-	-	27	-	2	-	1
		4	4	2	-	1	-	-	6	40	23	12	4	1	-
		8	4	3	2	1	1	-	7	28	64	93	13	4	1
	D. siciloides	1/2	-	-	-	-	-	-	-	88	1	-	-	-	-
		4	-	-	-	-	-	-	-	-	7	12	-	-	-
		8	-	-	-	-	1	-	-	-	5	-	-	+	-
	Eurytemora affinis	1/2	-	-	-	39	29	29	20	36	269	-	-	-	-
		4	-	-	15	-	7	20	10	32	14	-	-	-	-
		8	-	-	-	4	11	2	16	56	3	-	-	-	+
	Limnocalanus macrurus	1/2	-	-	-	-	-	-	-	-	-	-	-	-	-
		4	-	+	1	-	-	-	9	39	2	12	-	-	2
		8	2	1	24	5	4	17	47	51	111	45	10	18	13
	Immature Cyclopoid Copepodids	1/2	762	1045	4577	3950	5252	21366	19159	28349	9211	2008	3225	3276	1346
		4	1020	1107	7467	979	1921	6312	4788	12399	5778	4580	904	2088	705
		8	288	316	2392	532	1208	3276	2662	10099	2775	4522	489	624	315

Table 12 (continued). MEAN CONCENTRATIONS OF CRUSTACEAN ZOOPLANKTON (numbers/m^3)

	CRUISE		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
			1972										1973		
	IDENTIFICATION GROUP	KM													
CYCLOPOIDA	*Cyclops bicuspidatus thomasi*	1/2	741	418	146	135	219	1750	3031	2619	775	113	1618	183	26
		4	343	430	936	227	239	969	1437	985	662	445	380	216	55
		8	210	339	252	553	519	1175	933	887	287	110	356	186	48
	C. vernalis	1/2	-	4	10	50	49	-	-	-	10	-	-	-	-
		4	-	-	1	-	-	-	-	-	12	64	4	-	-
		8	-	-	-	1	-	9	5	11	9	-	-	+	-
	Eucyclops sp.	1/2	-	1	-	-	-	-	-	-	-	-	-	-	-
		4	-	+	-	-	-	-	-	-	-	-	-	-	-
	Mesocyclops edax	1/2	-	-	-	-	-	-	-	-	7	-	-	-	-
		4	-	-	-	-	-	17	5	-	-	-	-	-	-
		8	-	-	2	-	1	-	+	-	-	-	-	-	-
	Tropocyclops prasinus mexicanus	1/2	10	11	4	.33	155	1966	6000	3138	951	230	28	4	11
		4	13	12	24	9	35	506	512	1538	892	321	13	18	7
		8	14	19	1	-	19	184	332	1604	437	547	34	15	1
HARPACTICOIDA	Immature Harpacticoid Copepodids	1/2	1	59	34	-	-	-	-	-	5	-	2	-	3
		4	1	1	4	-	-	-	-	-	2	-	-	-	-
		8	-	-	-	-	-	-	-	-	2	-	-	1	-
	Bryocamptus nivalis	4	2	-	-	-	-	-	-	-	-	-	-	-	-
	Canthocamptus robertcokeri	1/2	5	9	26	20	-	-	-	-	-	-	2	-	-
		4	4	3	-	-	-	-	-	-	-	-	-	2	-
	C. staphylinoides	1/2	-	-	60	-	-	-	-	-	-	-	9	-	3
		4	-	-	-	-	-	-	-	-	-	-	-	1	-
	Mesochra alaskana	1/2	-	-	4	-	-	-	-	-	-	-	-	-	-
		4	-	-	-	-	-	-	-	-	-	-	+	-	-

Table 12 (continued). MEAN CONCENTRATIONS OF CRUSTACEAN ZOOPLANKTON
(numbers/m^3)

	CRUISE		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
			1972										1973		
	IDENTIFICATION GROUP	KM													
HARPACTICOIDA	*Moraria cristata*	1/2	1	-	-	-	-	-	-	-	-	-	-	-	-
	Nitocra hibernica	1/2	-	-	-	-	-	-	-	-	-	-	-	2	-
	N. spinepes	1/2	-	-	-	-	-	-	-	-	-	-	-	-	1

NOTE: (-) = 0; (+) = LESS THAN $1/M^3$

Table 13. SPATIAL DISTRIBUTION OF ZOOPLANKTON FOR THE FIRST (1), SECOND (2), AND THIRD (3) HIGHEST CONCENTRATIONS AT A SINGLE STATION FOR A SINGLE TIME

IDENTIFICATION GROUP	STATIONS							SINGLE STATION	GREATEST CONCENTRATION MONTH	GREATEST CONCENTRATION $\#/M^3$
1/2 KM	201	207	213	222	231	237	243			
Bosminids with Mucro			3		1		2	231	1-IX	352956
Ceriodaphnia lacustris					1	3	2	231	1-IX	43323
Daphnia retrocurva				2,3	1			231	1-IX	79001
Eubosmina coregoni						3	1,2	243	VI	6796
Copepod Nauplii				1,3	2			222	e-IX	80912
Immature Calanoid Copepodids				1	3		2	222	e-IX	5734
Immature Cyclopoid Copepodids				1	2		3	222	e-IX	70082
Cyclops bicuspidatus thomasi	3			1,2				222	1-IX	15291
Tropocyclops prasinus mexicanus					1	2	3	231	1-IX	25484
MEAN TOTAL ZOOPLANKTON				2	1		3	231	-	182609

Table 13 (continued). SPATIAL DISTRIBUTION OF ZOOPLANKTON FOR THE FIRST (1), SECOND (2), AND THIRD (3) HIGHEST CONCENTRATIONS AT A SINGLE STATION FOR A SINGLE TIME

IDENTIFICATION GROUP	STATIONS							SINGLE STATION	GREATEST CONCENTRATION MONTH	GREATEST CONCENTRATION $\#/M^3$
4 KM	202	208	214	223	232	238	244			
Bosminids with Mucro	1	2					3	202	e-IX	19164
Ceriodaphnia lacustris	2					3	1	244	e-IX	3695
Daphnia retrocurva	1					2	3	202	X	8306
Eubosmina coregoni				3		2	1	244	X	927
Copepod Nauplii	1	3					2	202	X	51724
Immature Calanoid Copepodids				2	3		1	244	X	811
Immature Cyclopoid Copepodids	1	3		2				202	X	30015
Cyclops bicuspidatus thomasi				2			1,3	244	VI	2366
Tropocyclops prasinus mexicanus	1			2	3			202	X	3775
MEAN TOTAL ZOOPLANKTON	3	2					1	244	-	21904

Table 13 (continued). SPATIAL DISTRIBUTION OF ZOOPLANKTON FOR THE FIRST (1), SECOND (2), AND THIRD (3) HIGHEST CONCENTRATIONS AT A SINGLE STATION FOR A SINGLE TIME

IDENTIFICATION GROUP	STATIONS							SINGLE STATION	GREATEST CONCENTRATION	
8 KM	203	209	215	224	233	239	245		MONTH	#/M³
Bosminids with Mucro	1,2					3		203	X	8235
Ceriodaphnia lacustris	1						2,3	203	X	3198
Daphnia retrocurva	2				3		1	245	1-IX	3155
Eubosmina coregoni	2					3	1	245	X	1243
Copepod Nauplii	2						1,3	245	1-IX	20873
Immature Calanoid Copepodids	2						1,3	245	X	497
Immature Cyclopoid Copepodids	2						1,3	245	X	17901
Cyclops bicuspidatus thomasi			3		1		2	233	1-IX	2216
Tropocyclops prasinus mexicanus	1					3	2	203	X	3758
MEAN TOTAL ZOOPLANKTON	2					3	1	245	-	14870

Table 14. MEAN CONCENTRATIONS OF CRUSTACEAN ZOOPLANKTON (numbers/m³)

	CRUISE	I	V	VI	VIII	IX	I	III	IV	VI	VII
		---------1972----------				1973	---------1972----------				1973-
	IDENTIFICATION GROUP	GENESEE RIVER MOUTH					NIAGARA RIVER MOUTH				
CLADOCERA	Bosminids with Mucro	69	57	12052	111	13	800	14844	18237	57	95
	Camptocercus rectirostris	-	-	-	-	-	-	-	3	-	-
	Ceriodaphnia lacustris	1	-	310	-	-	-	-	145	-	-
	Chydorus sphaericus	21	5	-	19	3	-	-	-	-	-
	Daphnia galeata mendotae	+	-	-	26	-	7	43	86	749	-
	D. longiremis	-	-	-	3	-	-	-	-	4	12
	D. retrocurva	1	-	449	407	2	76	43	88	7	5
	Diaphanosoma leuchtenbergianum	-	2	-	-	-	-	-	13	13	-
	Eubosmina coregoni	-	-	18	577	-	43	238	33	636	65
	Leptodora kindtii	-	-	17	-	-	-	-	-	-	-
	Macrothrix laticornis	-	-	-	4	-	-	-	-	-	-
	Copepod Nauplii	1204	592	12804	1584	3679	77843	52642	2296	8069	18683
CALANOIDA	Immature Calanoid Copepodids	20	19	177	174	48	24	352	118	192	634
	Diaptomus ashlandi	-	-	-	-	-	7	-	-	-	36
	D. minutus	1	-	-	3	4	9	-	-	-	26
	D. oregonensis	-	-	-	24	-	13	-	59	637	5
	D. pallidus	-	-	-	-	-	-	-	-	4	-
	D. sicilis	-	-	-	6	-	-	-	-	-	-
	D. siciloides	-	-	-	-	-	-	-	1	-	-
	Eurytemora affinis	-	-	6	2	-	-	-	-	-	-
CYCLOPOIDA	Immature Cyclopoid Copepodids	233	1375	6428	5511	1230	10847	55688	2106	1548	6187
	Cyclops bicuspidatus thomasi	4	-	522	277	-	3257	1727	209	375	214
	C. vernalis	+	-	-	-	-	77	-	-	16	-
	Eucyclops prionophorus	+	-	-	-	-	-	-	-	-	-

Table 14 (continued). MEAN CONCENTRATIONS OF CRUSTACEAN ZOOPLANKTON (numbers/m^3)

CRUISE	I	V	VI	VIII	IX	I	III	IV	VI	VII
	1972				1973	1972				1973
IDENTIFICATION GROUP	GENESEE RIVER MOUTH					NIAGARA RIVER MOUTH				
CYCLOPOIDA										
Mexocyclops edax	-	-	-	-	-	-	43	105	-	7
Tropocyclops prasinus mexicanus	1	1	90	842	7	25	-	40	29	-
HARPACTICOIDA										
Immature Harpacticoid Copepodids	4	4	-	2	1	14	-	1	5	4
Bryocamptus zschokkei	-	-	-	2	-	-	-	-	-	-
Canthocamptus robertcokeri	3	-	-	-	4	-	-	-	-	-
C. staphylinoides	-	-	-	-	-	-	-	-	6	-
Epactophanes richardi	-	-	-	-	-	-	-	-	4	-
Nitocra hibernica	-	-	-	-	-	-	-	4	-	-

NOTE: (-) = 0; (+) = LESS THAN 1/M^3

Table 15. BENTHIC ORGANISMS/m^2 IN THE NEARSHORE ZONE OF LAKE ONTARIO
CRUISE I, 1972

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213*	214	215	223	224	231*	232	233	238	239	243*	244	245*
Stylodrilus heringianus	172	2328				1179	548		272		454	249	1652	529	146	552	
Potamothrix vejdovskyi	1204					197										276	
P. moldaviensis	860					98					23				42	2208	
Tubifex tubifex	344	106			19	98	76		272		23	42		57		552	
Peloscolex ferox	688					98		57			68				42	276	
P. multisetosus						98											
Limnodrilus hoffmeisteri		212	1168			590	57		91		68		43	19	19	828	
L. maumeensis																	
L. claparedianus		106				98											
L. cervix																19	
L. udekemianus																	
Aulodrilus americanus															19		

Table 15 (continued). BENTHIC ORGANISMS/m² IN THE NEARSHORE ZONE OF LAKE ONTARIO CRUISE I, 1972

TAXA/SPECIES	STATION NUMBER 202	203	208	209	213	214	215	223	224	231	232	233	238	239	243	244	245
A. pluriseta																	
Unidentifiable immatures with capilliform chaetae	2247	317	195		19	295	265		847			166		151	21	3587	
without capilliform chaetae	4472	1058	195			1376	76	19	181		113	166	696	57	270	4139	
Mysis relicta		38															
Pontoporeia affinis		4120						19	57			19		94			
Gammarus fasciatus			19			227	1361		397			567	57	1606	19		
Asellus						38										907	
Orthocladiinae	151	57													19	38	
Tanytarsini								19									
Cryptochironomus								19					38				
Chironomus	170														19		
Procladius	472					76									19		
Helobdella stagnalis																	

Table 15 (continued). BENTHIC ORGANISMS/m² IN THE NEARSHORE ZONE OF LAKE ONTARIO
CRUISE I, 1972

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213	214	215	223	224	231	232	233	238	239	243	244	245
Sphaeriidae	1739	1890	2551			775	19	699	19		94	76	945	454	19	9526	
Gyraulus																	
Physa																	
Lymnaea																	
Valvata sincera	38		38														
Bithynia tentaculata																	
TOTAL ORGANISMS	13245	10232	4166	-	76	5243	2402	832	2136	-	843	1327	3431	2967	654	22905	-

* NO SAMPLES AT THIS STATION

Table 16. BENTHIC ORGANISMS PER M^2 IN THE NEARSHORE ZONE OF LAKE ONTARIO CRUISE III, 1972

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213	214	215	223	224	231	232	233	238	239	243	244	245
Stylodrilus heringianus	57	19	370	643		680	680	38		38	1349	132	57	1990		178	283
Potamothrix vejdovskyi	38		1111								79				76	1155	19
P. moldaviensis			2499													266	
Tubifex tubifex	38		1482	4177		76	76					57				622	
Pelescolex ferox	19	19		643							40					266	19
P. multisetosus						38											
Limnodrilus hoffmeisteri			4816	1606		38	38	38			79		14	102	19	622	208
L. maumcensis			370														
L. claparedianus																	
L. cervix																	
L. udekemianus																	
Aulodrilus americanus																	

Table 16 (continued). BENTHIC ORGANISMS PER M^2 IN THE NEARSHORE ZONE OF LAKE ONTARIO

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213*	214	215	223	224	231	232	233	238	239	243	244	245
A. pluriseta																	
Unidentifiable immatures with capilliform chaetae			741	3856		454	454				40	94			57	533	
without capilliform chaetae	94		5927	3213		76	76				40		57	102	19	888	246
Mysis relicta							2344	19	19								
Pontoporeia affinis									321			1134		1682	19	19	302
Gammarus fasciatus				38										19	19	850	
Asellus						19										132	
Orthocladiinae							94		19	19		19		38	19		
Tanytarsini																	
Cryptochironomus																	
Chironomus											19						
Procladius				19		57					19					38	
Helobdella stagnalis																19	

Table 16 (continued). BENTHIC ORGANISMS/m^2 IN THE NEARSHORE ZONE OF LAKE ONTARIO CRUISE III, 1972

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213	214	215	223	224	231	232	233	238	239	243	244	245
Sphaeriidae	737	19	7976	19		548	170	76	19		1795	57		397	113	5349	151
Gyraulus			57														
Physa			19														
Lymnaea																	
Valvata sincera																	
Bithynia tentaculata																	
TOTAL ORGANISMS	983	57	25368	18070	-	1986	3932	171	2079	57	3460	1493	133	4330	341	10937	1227

* NO SAMPLES AT THIS STATION

Table 17. BENTHIC ORGANISMS/m^2 IN THE NEARSHORE ZONE OF LAKE ONTARIO CRUISE VI, 1972

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213*	214	215	223	224	231*	232	233	238	239	243*	244	245
Stylodrilus heringianus	50	129	57	55		177	328	721	41		1053	359	803	180		312	1537
Potamothrix vejdovskyi			401								28		16			2807	
P. moldaviensis			287	28												936	77
Tubifex tubifex	50	43	115	249		2661	25	111	229				16	76			
Pelescolex ferox		43						55			139		31			624	77
P. multisetosus																	
Limnodrilus hoffmeisteri		171		360		532	126	83	16				173	19		312	269
L. maumeensis																	
L. claparedianus																	
L. cervix																	
L. udekemianus						355											
Aulodrilus americanus																	

Table 17 (continued). BENTHIC ORGANISMS/m^2 IN THE NEARSHORE ZONE OF LAKE ONTARIO CRUISE VI, 1972

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213	214	215	223	224	231	232	233	238	239	243	244	245
A. pluriseta																312	
Unidentifiable immatures with capilliform chaetae		171	745	28		2129	126	28	139			76		123		1871	
without capilliform chaetae		43	1491	721		1419	25	305	25		55	9	47	28		7173	346
Mysis relicta							76	25	20			6	13	44			19
Pontoporeia affinis		3377		25			4360		246		50	901	76	2010			3421
Gammarus fasciatus			107								50					13	
Asellus													6			6	
Orthoclodiinae		151					25				25		44	113			6
Tanytarsini			6														
Cryptochironomus																	
Chironomus				25													
Procladius	170		6			25							13				13
Helobdella stagnalis																	

Table 17 (continued). BENTHIC ORGANISMS/m^2 IN THE NEARSHORE ZONE OF LAKE ONTARIO CRUISE VI, 1972

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213	214	215	223	224	231	232	233	238	239	243	244	245
Sphaeriidae	19	252	5305	126		76	907	958	176		1789	19	737	265		2722	2564
Gyraulus			88										6				
Physa			6														
Lymnaea			239	25													
Valvata sincera																	
Bithynia tentaculata																	
TOTAL ORGANISMS	289	4380	8853	1642	-	7374	5998	2286	892	-	3189	1370	1981	2858	-	17088	8329

* NO SAMPLES AT THIS STATION

Table 18. BENTHIC ORGANISMS/m² IN THE NEARSHORE ZONE OF LAKE ONTARIO
CRUISE IX, 1972

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213*	214	215	223	224	231*	232	233	238	239	243	244*	245
Stylodrilus heringianus	688	189		58		403	340	1164	395		1842	912	1971	391			3704
Potamothrix vejdovskyi								265					290				423
P. moldaviensis	49	14		174							51						
Tubifex tubifex		42				1814	34		287			76		68			
Peloscolex ferox	98					202		106			307		232	68			106
P. multisetosus																	
Limnodrilus hoffmeisteri		69	92	348		605	23	106			51		116	34			
L. maumeensis																	
L. claparedianus																	
L. cervix																	
L. udekemianus																	
Aulodrilus americanus																	

Table 18 (continued). BENTHIC ORGANISMS/m² IN THE NEARSHORE ZONE OF LAKE ONTARIO
CRUISE IX, 1972

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213	214	215	223	224	231	232	233	238	239	243	244	245
A. pluriseta																	
Unidentifiable immatures with capilliform chaetae	49	263		290		3427	91	159	251			722		221			318
without capilliform chaetae	1032	42	1449	1739		3427	12	794	36		153	114	406	17	13		1058
Mysis relicta		6		13			19	25	50								25
Pontoporeia affinis	57	2054					1795	101	1140			2533		2281	6		5796
Gammarus fasciatus		6	315	25											6		
Asellus																	
Orthocladiinae		19										13		13			
Tanytarsini													25				
Cryptochironomus															50		
Chironomus	6																
Procladius	44		31	13		76											
Hellobdella stagnalis																	

Table 18 (continued). BENTHIC ORGANISMS PER M^2 IN THE NEARSHORE ZONE OF LAKE ONTARIO CRUISE IX, 1972

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213	214	215	223	224	231	232	233	238	239	243	244	245
Sphaeriidae	3238	220	5802	132		252	44	1109	220		1361	227	1411	296	19		2344
Gyraulus			435														
Physa			25														
Lymnaea	6		88			25											
Valvata sincera			6														
Bithynia tentaculata			13														
TOTAL ORGANISMS	5267	2924	8256	2792	-	10731	2358	3829	2379	-	3765	4597	4451	3389	94	-	13774

* NO SAMPLES AT THIS STATION

Table 19. BENTHIC ORGANISMS PER M² IN THE NEARSHORE ZONE OF LAKE ONTARIO CRUISE XI, 1973

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213*	214	215	223	224	231*	232	233	238	239	243*	244	245
Stylodrilus heringianus	695	575						624	561		1875	321	1149	253		575	3346
Potomothrix vejdovskyi	348		641					21					287				
P. moldaviensis	174		1922	181		316										287	176
Tubifex tubifex	87	431		2177		2841		42	21			19		19		1149	176
Pelescolex ferox			214			1262		42					575			862	176
P. multisetosus	87					631											
Limnodrilus hoffmeisteri	261	72	854	907		1578					234		575	19		2586	1055
L. maumcensis								21									
L. claparedianus																	
L. cervix																	
L. udekemianus																	
Aulodrilus americanus																	

Table 19 (continued). BENTHIC ORGANISMS PER M^2 IN THE NEARSHORE ZONE OF LAKE ONTARIO
CRUISE XI, 1973

TAXA/SPECIES	STATION NUMBER 202	203	208	209	213	214	215	223	224	231	232	233	238	239	243	244	245
A. pluriseta																	
Unidentifiable immatures with capilliform chaetae	348	503		2722		4419		83	249		176	19	287	58		2298	
without capilliform chaetae	956	179	4058	4536		2525		395	21		234	57	862	117		2873	2637
Mysis relicta				38		19	189	19	19		19						
Pontoporeia affinis	76	5273					3100		1247		907	1210	208	1606			2627
Gammarus fasciatus																907	
Asellus	76										38					132	
Orthoclodiinae		19						19			57		38			19	76
Tanytarsini											132		94				
Cryptochironomus																	
Chironomus																19	
Procladius						38							38			38	
Hellobdella stagnallis																	

Table 19 (continued). BENTHIC ORGANISMS PER M^2 IN THE NEARSHORE ZONE OF LAKE ONTARIO
CRUISE XI, 1973

TAXA/SPECIES	STATION NUMBER																
	202	203	208	209	213	214	215	223	224	231	232	233	238	239	243	244	245
Sphaeriidae	2722	605	4158	454		416	340		38		1436	151	1852			6709	3761
Gyraulus			94														
Physa																	
Lymnaea																	
Valvata sincera																	
Bithynia tentaculata																	
TOTAL ORGANISMS	5830	7657	11941	11015	-	14045	4574	1266	2156	-	5108	1777	5965	2072	-	18454	14024

* NO SAMPLES AT THIS STATION

Table 20. THE PERCENT (%) CONTRIBUTION OF MAJOR TAXA TO MEAN TOTAL MACROINVERTEBRATES AT NEARSHORE STATIONS IN LAKE ONTARIO, 1972-73 IFYGL

	STATIONS							
TAXA	**202**	**203**	**208**	**209**	**214**	**215**	**223**	**224**
Tubificidae	55.5	14.7	52.5	94.9	86.9	13.1	32.6	45.3
Stylodrilus heringianus	6.5	13.5	0.7	2.2	6.3	9.8	30.4	13.2
Mysis relicta	0	0.17	0	0.15	0.04	13.6	1.3	1.7
Asellus sp.	0.29	0	0	0	0.14	0	0	0
Chironomidae	3.9	0.97	0.07	0.17	0.69	0.71	0.67	0.19
Sphaeriidae	33.0	11.8	44.0	2.18	5.3	7.7	33.9	4.9
Gastropoda	0.17	0	1.9	0.07	0.06	0	0	0
Pontoporeia affinis	0.5	58.7	0	0.01	0.58	55.1	1.2	34.8
TOTAL %	99.86	99.84	99.47	99.68	100.01	100.01	100.07	100.09

Table 20 (continued). THE PERCENT (%) CONTRIBUTION OF MAJOR TAXA TO MEAN TOTAL MACROINVERTERRATES AT NEARSHORE STATIONS IN LAKE ONTARIO, 1972-73 IFYGL

	STATIONS						
TAXA	232	233	238	239	244	245	**MEAN**
Tubificidae	12.2	15.7	29.6	8.7	58.1	19.8	47.2
Stylodrilus heringianus	40.2	18.7	35.3	21.9	2.3	23.7	11.0
Mysis relicta	0.11	0.23	0.08	0.68	0	0.01	0.84
Asellus sp.	0.23	0	0.04	0	0.44	0	0.12
Chironomidae	1.5	0.3	1.06	1.49	0.16	0.25	0.71
Sphaeriidae	39.6	5.0	31.0	9.0	35.0	23.6	23.7
Gastropoda	0	0	0.04	0	0	0	0.31
Pontoporeia affinis	5.8	60.1	2.14	58.8	0.3	32.5	15.1
TOTAL %	99.64	100.03	99.26	100.27	96.0	99.86	98.98

Table 21. CLADOPHORA ANALYSIS 20 JUNE 1972

STATION #	DEPTH (M)	DRY WEIGHT (GM)	ASH FREE DRY WEIGHT (GM)
207	2	-	-
	3	3.84	2.27
	4	7.77	4.52
	5	6.54	4.19
	6	14.98	7.08

NOTE: NO OTHER STATIONS WERE SAMPLED DURING THIS TIME PERIOD

At each depth a total area of 0.27 square meters was sampled.

Table 22. CLADOPHORA ANALYSIS 26-28 JUNE 1972

STATION #	DEPTH (M)	DRY WEIGHT (GM)	ASH FREE DRY WEIGHT (GM)
207	2	7.71	3.10
	3	4.10	2.17
	4	6.19	3.13
	5	22.94	2.63
	6	4.55	2.84
216	2-6	NOT SAMPLED	
222	2	7.06	5.64
	3	9.84	3.19
	4	8.26	2.93
	5	40.53	3.62
	6	60.82	4.29
228	2-6	NOT SAMPLED	
237	2	-	-
	3	21.18	15.78
	4	10.60	7.08
	5	12.15	6.36
	6	3.60	1.52

At each depth a total of 0.27 square meters was sampled.

Table 23. CLADOPHORA ANALYSIS 11-20 JULY 1972

STATION #	DEPTH (M)	DRY WEIGHT (GM)	ASH FREE DRY WEIGHT (GM)
207	2	23.44	11.38
	3	20.69	16.01
	4	12.83	7.28
	5	8.63	6.01
	6	47.37	3.27
216	2	9.77	5.87
	3	35.98	21.09
	4	54.81	13.27
	5	29.62	16.07
	6	12.12	1.83
222	2	26.02	15.62
	3	15.85	12.66
	4	26.05	17.68
	5	22.00	12.29
	6	24.92	15.15
228	1	8.03	6.53
	2	10.29	6.94
	3	7.02	3.82
	4	9.68	6.21
	5	14.06	4.42
	6	3.83	2.16
237	2	-	-
	3	6.15	3.07
	4	-	-
	5	9.32	3.98
	6	5.56	3.64

At each depth a total of 0.27 square meters was sampled.

Table 24. CLADOPHORA ANALYSIS 27 JULY- 1 AUGUST 1972

STATION #	DEPTH (M)	DRY WEIGHT (GM)	ASH FREE DRY WEIGHT (GM)
207	2	-	-
	3	-	-
	4	7.47	3.35
	5	8.46	4.35
	6	4.86	3.64
216	2	-	-
	3	6.36	3.83
	4	5.77	2.66
	5	4.56	2.54
	6	5.79	2.26
222	2	9.49	6.07
	3	7.48	4.18
	4	6.52	4.07
	5	7.30	3.17
	6	11.32	5.23
228	2	3.39	2.92
	3	11.21	7.79
	4	1.87	1.51
	5	31.14	4.64
	6	42.01	7.23
237	2	-	-
	3	-	-
	4	27.65	18.88
	5	26.32	19.46
	6	8.35	6.12

At each depth a total of 0.27 square meters was sampled.

Table 25. CLADOPHORA ANALYSIS 8-17 AUGUST 1972

STATION #	DEPTH (M)	DRY WEIGHT (GM)	ASH FREE DRY WEIGHT (GM)
207	2	-	-
	3	17.69	5.72
	4	-	-
	5	69.96	15.70
	6	31.40	7.38
216	2	1.79	1.31
	3	1.78	1.30
	4	-	-
	5	5.86	4.29
	6	5.70	4.17
222	2	-	-
	3	0.31	0.24
	4	-	-
	5	21.90	4.29
	6	23.82	4.17
228	2-6	NOT SAMPLED	
237	2	0.61	0.54
	3	0.38	0.19
	4	1.24	0.91
	5	0.98	0.79
	6	0.45	0.42

At each depth a total of 0.27 square meters was sampled.

Table 26. *CLADOPHORA* ANALYSIS 20-27 OCTOBER 1972

STATION #	DEPTH (M)	DRY WEIGHT (GM)	ASH FREE DRY WEIGHT (GM)
207	2	-	-
	3	117.41	23.40
	4	110.09	16.26
	5	36.33	6.62
	6	81.34	12.38
216	2	-	-
	3	1.03	0.62
	4	1.26	0.22
	5	-	-
	6	-	-
222	2	1.85	1.22
	3	32.35	9.98
	4	76.38	11.19
	5	19.47	5.76
	6	54.41	8.26
228	2-6	NOT SAMPLED	
237	2-6	NOT SAMPLED	

At each depth a total of 0.27 square meters was sampled.

Table 27. CLADOPHORA ANALYSIS 2-15 MAY 1973

STATION #	DEPTH (M)	DRY WEIGHT (GM)	ASH FREE DRY WEIGHT (GM)
207	2	-	-
	3	34.88	6.00
	4	18.02	10.40
	5	11.09	6.01
	6	10.77	6.04
216	2	-	-
	3	0.98	0.43
	4	-	-
	5	-	-
	6	-	-
222	2	-	-
	3	2.38	1.02
	4	17.18	6.40
	5	50.22	12.84
	6	11.02	3.99
228	2	-	-
	3	7.24	2.32
	4	3.55	2.04
	5	19.87	6.02
	6	15.05	5.33
237	2	-	-
	3	-	-
	4	10.44	4.91
	5	18.62	8.58
	6	16.69	8.29

At each depth a total of 0.27 square meters was sampled.

Table 28. 1972-1973 IFYGL NITRATES IN SEDIMENTS

CRUISE	MEAN MG N/G	RANGE MG N/G
LAKE ONTARIO NEARSHORE ZONE		
I	0.076	0.003-0.231
III	0.029	0.002-0.094
VI	0.093	<0.001-0.329
IX	0.043	<0.001-0.230
XI	0.075	<0.001-0.273
GENESEE RIVER MOUTH		
I	0.059	0.02-0.10
V	0.030	0.02-0.06
VI	0.062	0.005-0.150
VIII	0.020	0.006-0.060
IX	0.029	<0.001-0.080
NIAGARA RIVER MOUTH		
I	0.024	0.010-0.050
III	0.018	0.009-0.026
IV	0.004	<0.001-0.010
VI	0.032	<0.010-0.128
VII	0.033	<0.010-0.110

Table 29. 1972-1973 IFYGL AMMONIA IN SEDIMENTS

CRUISE	MEAN MG N/G	RANGE MG N/G
LAKE ONTARIO NEARSHORE ZONE		
I	0.160	0.04-0.39
III	0.058	0.01-0.21
VI	0.163	0.02-0.35
IX	0.165	0.03-0.36
XI	0.204	0.05-0.56
GENESEE RIVER MOUTH		
I	0.065	0.02-0.15
V	0.070	0.01-0.21
VI	0.280	0.18-0.41
VIII	0.155	0.11-0.23
IX	0.061	0.03-0.13
NIAGARA RIVER MOUTH		
I	0.156	0.07-0.22
III	0.058	0.02-0.10
IV	0.137	0.03-0.23
VI	0.053	0.04-0.07
VII	0.035	0.02-0.07

Table 30. 1972-1973 IFYGL ORGANIC-N IN SEDIMENTS

CRUISE	MEAN MG N/G	RANGE MG N/G
LAKE ONTARIO NEARSHORE ZONE		
I	1.297	0.08-3.34
III	1.091	0.12-2.10
VI	1.453	0.07-2.96
IX	1.550	0.18-3.05
XI	2.180	0.17-6.29
GENESEE RIVER MOUTH		
I	0.885	0.31-1.49
V	0.599	0.17-1.44
VI	0.849	0.21-1.28
VIII	0.990	0.14-2.39
IX	0.803	0.41-1.41
NIAGARA RIVER MOUTH		
I	0.114	0.07-0.15
III	0.310	0.08-1.17
IV	0.197	<0.01-0.75
VI	0.148	0.03-0.31
VII	0.300	0.07-1.08

Table 31. 1972-1973 IFYGL TOTAL - N IN SEDIMENTS

CRUISE	MEAN MG N/G	RANGE MG N/G
LAKE ONTARIO NEARSHORE ZONE		
I	1.494	0.24-3.67
III	1.162	0.15-2.11
VI	1.706	0.25-3.39
IX	1.715	0.14-3.41
XI	2.450	0.30-4.03
GENESEE RIVER MOUTH		
I	1.010	0.35-1.61
V	0.731	0.19-1.69
VI	1.161	0.52-1.71
VIII	1.163	0.26-2.62
IX	0.894	0.49-1.56
NIAGARA RIVER MOUTH		
I	0.294	0.15-0.38
III	0.370	0.13-1.19
IV	0.350	0.09-0.99
VI	0.231	0.08-0.38
VII	0.364	0.12-1.11

Table 32. NIAGARA RIVER SEDIMENT CARBONATE AND ORGANIC CARBON (%) MEANS AND RANGES BY CRUISE FOR 1972-1973 IFYGL

CARBONATE CARBON (%)

CRUISE #	WESTERN ZONE			EASTERN ZONE		
	MEAN	RANGE	# OF SAMPLES	MEAN	RANGE	# OF SAMPLES
I	1.09	0.91-1.18	4	0.68	-	-
III	1.52	0.82-2.69	4	1.07	-	-
IV	1.35	0.30-3.00	9	0.99	-	-
VI	1.81	0.10-6.75	9	0.79	-	-
VII	1.25	0.11-2.79	7	-	-	-
TOTAL	1.44	0.10-6.75	33	0.88	0.68-1.07	4

ORGANIC CARBON (%)

I	0.11	0.07-0.16	4	0.05	-	-
III	0.22	0.05-0.66	4	0.05	-	-
IV	0.27	0.08-0.63	9	0.06	-	-
VI	0.09	0.03-0.12	9	0.07	-	-
VII	0.35	0.06-1.34	7	0.14	-	-
TOTAL	0.21	0.03-1.34	33	0.07	0.05-0.14	5

Table 33. LAKE ONTARIO SOUTHWESTERN NEARSHORE SEDIMENT
CARBONATE AND ORGANIC CARBON (%)
MEAN AND RANGE BY CONTOUR FOR 1972-1973 IFYGL

1/2 KM

CRUISE	CARBONATE CARBON			ORGANIC CARBON		
#	MEAN	RANGE	# OF SAMPLES	MEAN	RANGE	# OF SAMPLES
I	0.64	0.33-1.14	3	0.06	0.04-0.08	3
III	0.66	0.29-1.10	3	0.08	0.06-0.11	3
VI	0.88	0.63-1.10	3	0.27	0.03-0.71	3
IX	0.36	-	1	0.06	-	1
XI	0.61	-	1	0.07	-	1
TOTAL	0.63	0.29-1.14	11	0.11	0.03-0.71	11

4 KM

CRUISE	CARBONATE CARBON			ORGANIC CARBON		
#	MEAN	RANGE	# OF SAMPLES	MEAN	RANGE	# OF SAMPLES
I	1.29	0.18-2.33	14	0.84	0.09-2.32	14
III	1.22	0.22-2.70	15	0.87	0.10-2.00	15
VI	1.18	0.49-2.03	14	1.16	0.22-2.21	14
IX	1.27	0.43-2.02	15	1.05	0.18-2.35	15
XI	1.32	0.54-2.19	15	1.11	0.13-2.51	15
TOTAL	1.26	0.18-2.70	73	1.01	0.09-2.51	73

Table 33 (continued). LAKE ONTARIO SOUTHWESTERN NEARSHORE SEDIMENT CARBONATE AND ORGANIC CARBON (%) MEAN AND RANGE BY CONTOUR FOR 1972-1973 IFYGL

CRUISE	CARBONATE CARBON			ORGANIC CARBON		
#	MEAN	RANGE	# OF SAMPLES	MEAN	RANGE	# OF SAMPLES
I	1.10	0.51-2.67	15	1.35	0.38-1.93	15
III	0.87	0.04-2.38	14	1.49	0.25-2.40	15
VI	0.81	0.18-1.95	14	1.56	0.49-2.25	14
IX	0.87	0.28-2.37	15	1.58	0.48-2.25	15
XI	0.96	0.09-2.26	15	1.59	0.42-2.80	15
TOTAL	0.92	0.04-2.67	73	1.51	0.38-2.80	74

Table 34. GENESEE RIVER SEDIMENT CARBONATE AND ORGANIC CARBON (%) MEANS AND RANGES BY CRUISE FOR 1972-1973 IFYGL

CRUISE #	CARBONATE CARBON (%) MEAN	RANGE	# OF SAMPLES	ORGANIC CARBON (%) MEAN	RANGE	# OF SAMPLES
I	0.85	0.40-1.44	10	1.00	0.27-3.11	11
V	0.82	0.06-1.29	11	0.65	0.09-1.55	11
VI	0.69	0.05-1.07	11	1.27	0.21-4.25	12
VIII	0.68	0.19-1.15	12	1.00	0.56-1.98	12
IX	0.69	0.39-1.14	10	0.81	0.19-1.82	12
TOTAL	0.75	0.05-1.44	54	0.95	0.09-4.25	58

Table 35. SEDIMENT METAL CONCENTRATIONS BY CRUISE

(µG/G)

ALL VALUES µG/G		MAGNESIUM		IRON		MANGANESE		ZINC	
REGION	CRUISE*	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE
NIAGARA RIVER MOUTH	I	-	-	-	-	-	-	-	-
	III	-	-	-	-	-	-	-	-
	IV	8,000	3,800-20,000	9,100	4,100-18,500	284	81-606	75	17-184
	VI	16,300	3,800-20,000	11,600	7,300-20,000	264	161-436	56	27-142
	VII	11,863	6,000-17,000	8,000	6,200-14,000	298	123-438	58	33-82
LAKE ONTARIO NEARSHORE	I	8,530	1,200-12,500	-	-	568	130-1,880	153	10-950
	III	6,400	1,300-12,500	-	-	366	50-730	160	10-590
	VI	8,400	1,200-20,000	36,600	5,700-75,000	600	96-1,300	176	17-930
	IX	8,600	2,400-20,000	32,900	5,300-78,000	590	90-1,580	187	30-670
	XI	8,200	1,200-17,000	32,400	2,900-76,000	705	50-1,700	184	20-1,120
GENESEE RIVER MOUTH	I	-	-	-	-	-	-	-	-
	V	-	-	-	-	-	-	-	-
	VI	5,740	1,100-8,400	21,500	4,100-29,000	308	50-420	142	25-400
	VIII	5,680	3,800-8,200	25,600	3,500-32,000	279	148-350	141	34-350
	IX	5,370	2,600-9,000	21,900	7,700-40,600	375	116-792	141	27-500

*SEE TEXT FOR EXPLANATION OF OMISSIONS

Table 35 (continued). SEDIMENT METAL CONCENTRATIONS BY CRUISE

(µG/G)

REGION	CRUISE #	CHROMIUM		COPPER		CADMIUM	
		OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE
NIAGARA RIVER MOUTH	I	13	<10-25	<7.0	<7.0	2.3	<2.0-3.4
	III	34	<10-56	<7.0	<7.0	<3.0	<3.0
	IV	33	<12-68	14	<10-21	3.6	2.9-5.5
	VI	34	<8-49	10	<10-12	3.6	1.3-7.8
	VII	17	<8-35	12	6-24	5.6	2.6-8.4
LAKE ONTARIO NEARSHORE	I	72	10-220	44	7-82	-	-
	III	87	10-245	44	7-145	4.9	1.5-10.0
	VI	87	12-163	33	10-70	4.6	1.0-10.0
	IX	74	21-183	30	7-81	4.1	1.0-8.1
	XI	78	8-179	38	5-77	6.0	1.6-12.6
GENESEE RIVER MOUTH	I	41	5-143	14	7-31	3.6	2.0-8.0
	V	39	8-83	11	7-24	3.9	2.0-7.3
	VI	32	10-50	17	10-39	5.8	2.9-11.0
	VIII	50	29-72	25	12-39	7.6	2.4-18.3
	IX	32	-	21	5-50	4.2	2.6-8.4

Table 35 (continued). SEDIMENT METAL CONCENTRATIONS BY CRUISE
(µG/G)

REGION	CRUISE #	LEAD		MERCURY		NICKEL	
		OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE
NIAGARA RIVER MOUTH	I	11	<10-13	0.14	0.07-0.32	-	-
	III	10	<10-11	0.11	<0.05-0.18	-	-
	IV	17	<10-35	0.24	0.09-0.49	65	12-160
	VI	18	<10-28	0.14	<0.10-0.29	20	12-49
	VII	33	20-42	0.21	<0.10-0.66	18	11-35
LAKE ONTARIO NEARSHORE	I	49	10-100	1.49	0.08-4.10	-	-
	III	52	7-165	1.06	0.05-4.59	-	-
	VI	49	10-115	2.12	0.17-7.76	54	20-115
	IX	45	10-119	1.77	0.08-7.11	45	19-92
	XI	60	10-134	2.43	0.10-7.07	42	12-84
GENESEE RIVER MOUTH	I	30	<10-80	0.28	0.10-0.61	-	-
	V	19	6-72	0.18	0.07-0.45	-	-
	VI	26	<10-46	0.42	0.06-0.41	72	20-140
	VIII	29	10-45	0.26	0.03-0.67	35	12-49
	IX	30	<10-83	0.29	0.08-0.62	28	9-52

Table 36. LIMITS OF DETECTION FOR ELECTED TOXICANTS IN THE SEDIMENT

TOXICANT	LIMIT OF DETECTION μG/G
lindane	0.02
heptachlor	0.02
aldrin	0.02
heptachlor epoxide	0.02
dieldrin	0.02
p,p'DDE	0.02
o,p'FDE	0.05
endrin	0.02
o,p'DDF	0.05
p,p'FDE	0.05
p,p'DDF	0.05
chlordane	0.50
toxaphene	1.00
PCB's	0.50

Table 37. TOTAL PHOSPHORUS IN MG P/LITER

	UNITHERMAL 1972		STRATIFICATION		UNITHERMAL 1973	
	MEAN AVERAGE	RANGE	MEAN AVERAGE	RANGE	MEAN AVERAGE	RANGE
NIAGARA RIVER						
ABOVE 20 M	0.013	0.009-0.017	0.311	0.029-0.822	0.042	0.027-0.109
BELOW 20 M	-	-	-	-	-	-
LAKE ONTARIO						
ABOVE 20 M	0.016	0.007-0.041	0.024	0.013-0.049	0.026	0.017-0.058
BELOW 20 M	0.017	0.008-0.043	0.020	0.006-0.041	0.025	0.018-0.045
GENESEE RIVER						
ABOVE 20 M	0.037	0.019-0.069	0.172	0.036-0.225	0.035	0.020-0.077
BELOW 20 M	-	-	-	-	-	-

Table 38. DISSOLVED PHOSPHORUS IN MG P/LITER

	UNITHERMAL 1972		STRATIFICATION		UNITHERMAL 1973	
	MEAN AVERAGE	RANGE	MEAN AVERAGE	RANGE	MEAN AVERAGE	RANGE
NIAGARA RIVER	0.011	0.008-0.020	0.006	0.004-0.011	0.013	0.011-0.020
LAKE ONTARIO						
ABOVE 20 M	0.014	0.005-0.066	0.007	0.004-0.026	0.014	0.008-0.025
BELOW 20 M	0.010	0.006-0.015	0.008	0.003-0.019	0.014	0.006-0.025
GENESEE RIVER	-	-	0.008	0.004-0.018	0.017	0.009-0.028

Table 39. ORTHO PHOSPHORUS IN MG P/LITER

	UNITHERMAL 1972		STRATIFICATION		UNITHERMAL 1973	
	MEAN AVERAGE	RANGE	MEAN AVERAGE	RANGE	MEAN AVERAGE	RANGE
NIAGARA RIVER	0.001	0.001-0.003	0.002	0.001-0.008	-	-
LAKE ONTARIO						
ABOVE 20 M	0.003	0.001-0.020	0.002	0.001-0.012	-	-
BELOW 20 M	0.002	0.001-0.007	0.003	0.001-0.007	-	-
GENESEE RIVER	0.001	0.001-0.002	0.002	0.001-0.005	-	-

Table 40. NIAGARA RIVER MOUTH NITRATES IN WATER (MG/L) MEANS AND RANGES BY CRUISE FOR 1972-1973 IFYGL

CRUISE	I	II	III	IV	V	VI	VII
SURFACE							
MEAN	0.410	0.431	0.073	0.038	0.173	0.144	0.579
RANGE	0.10->2.0	0.05->2.0	0.01-0.20	0.008-0.077	0.012-0.764	0.096-0.202	0.255-2.00
MID-DEPTH							
MEAN	0.217	0.182	0.095	0.025	0.334	0.171	0.401
RANGE	0.10-1.1	0.05-1.3	0.01-0.60	0.010-0.068	0.050-1.32	0.096-0.262	0.260-0.536
BOTTOM							
MEAN	0.148	0.351	0.064	0.028	0.265	0.149	0.462
RANGE	0.05-0.60	0.01-2.0	0.01-0.26	0.008-0.070	0.042-1.008	0.101-0.222	0.256-0.986
OVERALL							
MEAN	0.254	0.326	0.078	0.030	0.251	0.156	0.479
RANGE	0.05->2.0	0.03->2.0	0.01-0.60	0.008-0.077	0.012-1.32	0.096-0.262	0.255-2.00

Table 41. LAKE ONTARIO NITRATES IN WATER (MG/L) MEANS AND RANGES BY CRUISE FOR 1972-1973 IFYGL

	CRUISE I	II	III	IV	V
SURFACE					
MEAN	0.431	0.287	0.065	0.032	0.040
RANGE	0.10- 1.4	0.02- 0.50	0.01- 0.20	<0.02- 0.20	<0.02- 0.10
MID-DEPTH					
MEAN	0.511	0.363	0.160	0.129	0.117
RANGE	0.20- 1.0	0.10- 0.70	0.01- 0.20	<0.02- 0.30	<0.02- 0.20
BOTTOM					
MEAN	0.414	0.342	0.152	0.165	0.149
RANGE	0.20- 1.0	0.10- 0.60	0.02- 0.30	<0.02- 0.30	<0.02- 0.30
OVERALL					
MEAN	0.454	0.333	0.122	0.110	0.102
RANGE	0.10- 1.2	0.02- 0.70	0.01- 0.30	<0.02- 0.30	<0.02- 0.30

Table 42. GENESEE RIVER MOUTH NITRATES IN WATER (MG/L) MEANS AND RANGES BY CRUISE FOR 1972-1973 IFYGL

	CRUISE			
	II	III	IV	V
SURFACE				
MEAN	0.208	0.345	0.045	0.313
RANGE	0.10-0.70	0.02-1.5	0.003-0.10	0.04-1.1
MID-DEPTH				
MEAN	0.175	0.210	0.029	0.223
RANGE	0.10-0.30	0.02-1.3	0.003-0.04	0.05-0.60
BOTTOM				
MEAN	0.225	0.202	0.049	0.095
RANGE	0.10-0.50	0.01-0.50	0.02-0.10	0.05-0.10
OVERALL				
MEAN	0.203	0.254	0.041	0.217
RANGE	0.10-0.70	0.01-1.5	0.003-0.10	0.04-1.1

Table 43. NIAGARA RIVER MOUTH AMMONIA IN WATER (MG/L) MEANS AND RANGES BY CRUISE FOR 1972-1973 IFYGL

	CRUISE						
	I	II	III	IV	V	VI	VII
SURFACE							
MEAN	0.037	0.061	0.084	0.042	0.059	0.078	0.054
RANGE	0.005-0.145	0.005-0.255	0.005-0.395	0.005-0.235	0.020-0.223	0.063-0.097	0.027-0.077
MID-DEPTH							
MEAN	0.062	0.090	0.052	0.038	0.061	0.080	0.042
RANGE	0.003-0.825	0.005-1.45	0.007-0.177	0.007-0.267	0.025-0.135	0.064-0.111	0.023-0.065
BOTTOM							
MEAN	0.023	0.039	0.061	0.031	0.056	0.065	0.039
RANGE	0.005-0.272	0.005-0.133	0.005-0.275	0.010-0.057	0.018-0.152	0.062-0.092	0.015-0.054
OVERALL							
MEAN	0.041	0.062	0.065	0.037	0.059	0.079	0.045
RANGE	0.003-0.825	0.005-1.45	0.005-0.395	0.005-0.262	0.018-0.223	0.062-0.111	0.015-0.077

Table 44. LAKE ONTARIO AMMONIA IN WATER (MG/L) MEANS AND RANGES BY CRUISE FOR 1972-1973 IFYGL

	CRUISE				
	I	II	III	IV	V
SURFACE					
MEAN	0.004	0.005	0.014	0.014	0.031
RANGE	0.003-0.005	<0.005-0.010	<0.005-0.045	<0.005-0.107	<0.005-0.095
MID-DEPTH					
MEAN	0.004	0.005	0.014	0.026	0.043
RANGE	0.003-0.005	<0.005-0.005	<0.005	0.005-0.067	0.005-0.170
BOTTOM					
MEAN	0.004	0.005	0.009	0.026	0.031
RANGE	0.003-0.005	<0.005-0.005	<0.005-0.019	0.005-0.087	<0.005-0.073
OVERALL					
MEAN	0.004	0.005	0.012	0.022	0.034
RANGE	0.003-0.005	<0.005-0.010	<0.005-0.045	<0.005-0.107	<0.005-0.170

Table 45. GENESEE RIVER MOUTH AMMONIA IN WATER (MG/L) MEANS AND RANGES BY CRUISE FOR 1972-1973 IFYGL

	CRUISE			
	II	III	IV	V
SURFACE				
MEAN	0.013	0.010	<0.005	0.251
RANGE	0.005-0.025	<0.005-0.040	<0.005	0.009-0.775
MID-DEPTH				
MEAN	0.013	0.006	<0.005	0.055
RANGE	0.005-0.030	<0.005-0.020	<0.005	0.003-0.245
BOTTOM				
MEAN	0.013	0.005	<0.005	0.018
RANGE	0.005-0.025	<0.005-0.005	<0.005	0.007-0.033
OVERALL				
MEAN	0.013	0.007	<0.005	0.105
RANGE	0.005-0.030	<0.005-0.040	<0.005	0.003-0.775

Table 46. DEGREE OF COMPLETION OF WATER ANALYSIS FOR MN, NI, CU, AND ZN CONCENTRATIONS

REGION	CRUISE	DEPTH	# OF SAMPLES ANALYZED	% OF TOTAL	STATIONS ANALYZED	DESCRIPTION OF AREA
LAKE ONTARIO NEARSHORE	I	S	25	56	206-221,223-231.	Just east of the Niagara River, to the center of the area.
		B	22	49	207,210-218,220,221, 223-231,239.	
	VI	S	6	13	203,204,207,208,214, 215.	Six sparse stations between Port Weller and Olcott (No zinc).
		B	6	13	203,204,207,209,213, 214.	
	VIII	S	16	35	219-222,229-235,240, 241,243-245.	Sparse stations in the eastern half (No nickel).
		B	14	31	219-222,228,230,231, 233,240-245.	
	IX	S	40	89	All but 207,216,217, 224,226.	Almost the whole area.
		B	45	100	201-245 (All).	
	X	S	10	22	201-210.	Three complete transects near the Niagara River mouth.
		B	10	22	201-210.	
	XI	S	40	89	All but 207,209,211, 238,237.	Almost the whole area.
		B	39	87	All but 207-209,212, 228,231.	

Table 46 (continued). DEGREE OF COMPLETION OF WATER ANALYSIS FOR MN, NI, CU, AND ZN CONCENTRATIONS

REGION	CRUISE #	DEPTH	# OF SAMPLES ANALYZED	% OF TOTAL	STATIONS ANALYZED	DESCRIPTION OF AREA
LAKE ONTARIO NEARSHORE	XII	S	39	89	All but 206,209,211, 238,239.	Almost the whole surface area, about 1/3 incomplete bottom.
		B	30	66	204-210,218,222-230 232-245.	
	XIII	S	43	96	All but 205,225.	Almost the whole area.
		B	44	98	All but 243.	
NIAGARA RIVER MOUTH	VI			100	All.	
GENESEE RIVER MOUTH	VIII and IX			100	All.	

Table 47. TOXIC METALS CONCENTRATIONS IN WATER BY CRUISE (MG/L)

REGION	CRUISE#	DEPTH	MANGANESE OVERALL AVERAGE	MANGANESE RANGE	NICKEL OVERALL AVERAGE	NICKEL RANGE	ZINC OVERALL AVERAGE	ZINC RANGE	COPPER OVERALL AVERAGE	COPPER RANGE
NIAGARA RIVER MOUTH	VI	S	41.3	4.0-119.0	20	8-26	141	23-224	46	31-67
		B	42.9	8.0-146.0	21	13-35	160	18-292	49	29-88
LAKE ONTARIO NEARSHORE	I	S	8.4	1.0-24.0	-	-	15	3-36	17	2-52
		B	13.9	3.0-43.0	-	-	14	1-39	15	3-37
	VI	S	34.8	14.0-75.0	66	55-79	-	-	106	87-120
		B	36.5	17.5-52.5	74	63-101	-	-	118	107-144
	VIII	S	14.2	2.0-41.0	22	16-35	135	72-189	55	28-105
		B	10.6	3.0-26.0	23	17-34	141	73-205	58	33-108
	IX	S	6.6	1.0-25.0	19	7-26	92	46-233	49	18-111
		B	7.7	2.0-35.0	19	10-27	94	50-162	54	25-94
	X	S	21.2	3.0-60.0	16	9-21	201	190-237	57	52-63
		B	15.2	6.0-26.0	17	8-27	218	185-360	59	52-75
	XI	S	14.1	3.0-87.0	23	13-37	31	10-146	17	5-28
		B	12.0	3.0-45.0	24	15-45	30	13-150	15	7-28
	XII	S	8.8	1.0-29.0	14	3-47	16	8-32	18	3-25
		B	6.7	1.0-18.0	12	7-32	12	4-66	15	2-30
	XIII	S	14.9	1.0-81.0	9	1-40	85	26-250	76	14-258
		B	10.3	2.0-43.0	10	1-40	80	26-223	81	15-294
GENESEE RIVER MOUTH	VIII	S	18.6	4.0-61.0	16	10-21	190	83-536	50	23-155
		B	27.5	4.0-70.0	17	13-24	163	92-441	49	28-94
	IX	S	21.0	3.0-53.0	18	13-26	90	53-134	78	5-150
		B	9.0	4.0-18.0	17	11-38	67	15-116	69	3-94

Table 48. NIAGARA RIVER WATER TOTAL ORGANIC CARBON MG/L) MEANS AND RANGES BY CRUISE FOR 1972-1973 IFYGL

CRUISE	SURFACE			BOTTOM		
#	MEAN	RANGE	# OF SAMPLES	MEAN	RANGE	# OF SAMPLES
I	3.7	2.0-5.5	20	3.8	2.2-7.6	19
II	2.5	1.9-3.9	12	2.7	2.0-6.0	11
VI	3.1	1.0-6.7	21	2.9	1.0-7.5	22
VII	2.6	1.9-3.8	24	2.7	1.6-5.4	24
TOTAL	3.0	1.0-6.7	77	3.0	1.0-7.6	76

Table 49. LAKE ONTARIO SOUTHWESTERN NEARSHORE WATER
TOTAL ORGANIC CARBON (MG/L)
MEANS AND RANGES BY CRUISE AND CONTOUR FOR 1972-1973 IFYGL

CRUISE	SURFACE			BOTTOM		
#	MEAN	RANGE	# OF SAMPLES	MEAN	RANGE	# OF SAMPLES
			1/2 KM			
I	3.8	1.0-6.7	11	3.0	1.7-5.7	11
VII	2.4	1.0-3.4	12	2.4	1.2-3.9	11
IX	3.0	1.9-4.4	14	3.4	2.0-5.8	14
XI	3.7	2.5-4.9	15	3.8	3.0-4.7	11
XII	3.1	1.9-4.9	13	2.7	2.0-3.7	9
XIII	3.1	2.8-8.0	15	2.8	1.7-3.8	15
TOTAL	3.2	1.0-8.0	80	3.0	1.2-5.8	71
			4 KM			
I	3.5	2.2-6.2	8	3.6	1.5-9.1	10
VII	2.3	1.2-3.8	13	2.0	0.9-3.6	12
IX	2.8	1.5-4.3	13	3.5	1.9-5.5	13
XI	4.1	2.4-8.2	15	3.7	2.6-7.1	14
XII	3.0	2.3-3.9	14	2.6	1.9-3.7	10
XIII	2.9	2.0-4.3	15	3.0	2.4-4.2	15
TOTAL	3.1	1.2-8.2	78	3.1	0.9-9.1	74

Table 49 (continued). LAKE ONTARIO SOUTHWESTERN NEARSHORE WATER TOTAL ORGANIC CARBON (MG/L)
MEANS AND RANGES BY CRUISE AND CONTOUR FOR 1972-1973 IFYGL

CRUISE	SURFACE			BOTTOM		
#	MEAN	RANGE	# OF SAMPLES	MEAN	RANGE	# OF SAMPLES
			8 KM			
I	2.7	1.0-4.7	12	3.5	0.7-6.4	12
VII	2.1	1.0-3.7	13	1.9	1.0-4.7	13
IX	3.0	1.8-5.8	15	3.1	1.8-6.1	15
XI	3.7	2.6-5.5	14	3.2	2.3-3.9	13
XII	3.0	1.4-4.5	14	2.3	1.3-3.2	11
XIII	3.2	2.1-5.1	15	2.9	1.5-5.1	14
TOTAL	2.9	1.0-5.8	83	2.8	0.7-6.4	78

Table 50. DEGREE OF COMPLETION OF WATER ANALYSIS FOR CA, MG, NA, AND K CONCENTRATIONS

REGION	CRUISE #	DEPTH	# OF SAMPLES ANALYZED	% OF TOTAL	STATIONS ANALYZED	DESCRIPTION OF AREA
LAKE ONTARIO NEARSHORE	I	S	23	51	201-204,209,210,216-218, 224,227,229-238,241,244, 245.	Sparse near the Niagara River, primarily the east central area.
		B	23	51	204,206,209,211,216-218, 224,227-238,241,244,245.	
	II	S	22	49	201-205,213-215,220-222, 231,232,235-241,243,244.	Sparse stations near both river mouths.
		B	14	31	202-205,210,213,216, 234-238,243,244.	
	IV	S	23	51	204,205,207,208,213-218, 221,224,228,229,231,234, 239,243-245.	Even distribution of samples.
		B	23	51	204,205,207,213-218,221-224,228,229,231,232,240-245.	
	VI	S	36	80	All but 201-206,216,237, 244.	Almost the whole area.
		B	34	75	All but 201-206,216,218, 228,239,241.	

Table 50 (continued). DEGREE OF COMPLETION OF WATER ANALYSIS FOR CA, MG, NA, AND K CONCENTRATIONS

REGION	CRUISE #	DEPTH	# OF SAMPLES ANALYZED	% OF TOTAL	STATIONS ANALYZED	DESCRIPTION OF AREA
LAKE ONTARIO NEARSHORE	VII	S	40	89	All but 206,210-212,215.	Almost the whole area.
		B	37	82	All but 206,207,208,210, 215,216,221,228.	
	VIII	S	41	91	All but 205,230,235,239.	Almost the whole area.
		B	40	89	All but 201,208,215,219, 220.	
	IX	S	38	84	All but 201,202,214,219, 224,241,245.	Almost the whole area.
		B	41	91	All but 205,211,237,244.	
	X	S	10	22	201-210.	Three transects near the Niagara River Mouth.
		B	10	22	201-210.	
	XI	S	43	96	All but 203,239.	Almost the whole area.
		B	35	78	All but 202,203,207-209, 212,213,228,231,237.	
NIAGARA RIVER MOUTH	II	S	9	38	368-372,375,380,384.	Sparse stations generally in the central area.
		B	6	25	368,370,371,375,384,385.	
	III, VI and VII			100	All.	
GENESEE RIVER MOUTH	VIII and IX			100	All.	

Table 51. DEGREE OF COMPLETION OF WATER ANALYSIS FOR FE

REGION	CRUISE #	DEPTH	# OF SAMPLES ANALYZED	% OF TOTAL	STATIONS ANALYZED	DESCRIPTION OF AREA
LAKE ONTARIO NEARSHORE	VI	S	7	16	203,204,207-209,214,215.	Sparse samples near the Niagara River Mouth.
		B	6	13	203,204,207,209,213,214.	
	VIII	S	16	36	219-222,229-235,240,241, 243-245.	Sparse samples in the central and eastern areas.
		B	18	40	219-222,228,230,231,233, 240-245.	
	IX	S	42	93	All but 207,216,217.	Almost the whole area.
		B	45	100	201-245.	
	X	S	10	22	201-210.	Three transects near the Niagara River.
		B	10	22	201-210.	
	XI	S	40	89	All but 207,209,211,238, 239.	Almost the whole area.
		B	39	87	All but 207-209,212,228, 231.	
	XII	S	38	84	All but 206,219,226,228-231.	Almost the whole area.
		B	31	69	All but 201-203,210-217, 219-221,231.	

Table 51 (continued). DEGREE OF COMPLETION OF WATER ANALYSIS FOR FE

REGION	CRUISE #	DEPTH	# OF SAMPLES ANALYZED	% OF TOTAL	STATIONS ANALYZED	DESCRIPTION OF AREA
LAKE ONTARIO NEARSHORE	XIII	S	43	96	All but 205,225.	Almost the whole area.
		B	44	98	All but 243.	
NIAGARA RIVER MOUTH	VI			100	All.	
GENESEE RIVER MOUTH	VIII and IX			100	All.	

Table 52. QUALITY INDICATIVE METAL CONCENTRATIONS IN WATER BY CRUISE (MG/L)

		CALCIUM				MAGNESIUM			
		SURFACE		BOTTOM		SURFACE		BOTTOM	
REGION	CRUISE#	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE
NIAGARA RIVER MOUTH	II	35.7	35.1-37.3	35.5	35.1-36.2	7.5	7.4-8.0	7.5	7.4-7.6
	III	36.0	35.1-37.8	35.9	35.1-37.7	7.7	7.5-8.4	7.6	7.5-8.3
	VI	35.6	33.6-38.0	36.2	34.8-40.4	7.6	6.8-8.8	7.8	7.2-10.0
	VII	37.3	35.5-39.6	37.1	31.4-39.5	7.9	7.7-8.2	8.0	7.8-8.4
LAKE ONTARIO NEARSHORE	I	43.1	35.5-48.3	42.8	34.4-47.4	8.0	5.5-8.8	8.2	5.8-8.8
	II	43.6	35.8-54.3	41.0	35.5-49.2	8.4	5.1-9.4	8.4	7.9-8.8
	IV	35.8	32.8-39.0	38.4	35.3-42.7	7.1	7.0-7.4	7.2	7.1-7.7
	VI	36.9	33.7-55.2	38.1	34.9-43.3	7.4	6.9-8.0	7.4	7.0-7.9
	VII	37.6	33.5-39.6	38.7	33.5-43.2	7.9	7.1-8.4	8.0	6.8-8.4
	VIII	37.9	31.0-41.9	38.5	33.5-42.4	7.8	6.4-8.5	7.8	6.3-8.4
	IX	39.0	34.7-45.2	39.0	35.7-47.0	7.8	7.3-9.8	7.9	7.3-10.5
	X	37.0	34.7-38.7	37.5	34.8-43.2	8.0	7.5-9.0	7.7	7.3-8.7
	XI	37.1	33.2-39.7	37.1	35.2-39.0	7.5	7.2-8.2	7.6	7.2-8.3
GENESEE RIVER MOUTH	VIII	38.3	34.9-43.3	43.9	34.3-63.4	8.0	7.3-9.3	9.0	7.0-14.6
	IX	40.2	36.9-43.5	39.1	37.7-40.4	8.2	7.5-9.7	7.5	7.3-7.8

Table 52 (continued). QUALITY INDICATIVE METAL CONCENTRATIONS IN WATER BY CRUISE (MG/L)

		SODIUM				POTASSIUM			
		SURFACE		BOTTOM		SURFACE		BOTTOM	
REGION	CRUISE#	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE
NIAGARA RIVER MOUTH	II	12.70	11.70-14.40	12.90	12.60-13.30	1.37	1.32-1.46	1.38	1.31-1.51
	III	12.90	12.40-14.50	12.70	12.20-14.60	1.39	1.30-1.66	1.40	1.32-1.65
	VI	12.60	12.00-13.60	12.70	12.20-13.40	1.41	1.28-1.83	1.42	1.31-2.08
	VII	14.60	11.70-18.80	12.89	11.20-18.10	2.04	1.36-3.44	1.65	1.32-3.06
LAKE ONTARIO NEARSHORE	I	11.75	9.43-15.20	12.06	8.43-13.84	1.50	1.33-1.69	1.53	1.37-1.78
	II	12.74	10.62-15.13	12.64	11.66-14.26	1.57	1.41-1.82	1.55	1.40-1.74
	IV	13.21	11.40-15.80	13.54	11.00-16.20	1.47	1.22-1.73	1.58	1.23-2.01
	VI	12.90	11.30-15.30	13.10	11.60-15.20	1.36	1.14-1.76	1.39	1.06-1.89
	VII	12.90	11.30-14.70	12.95	12.20-14.00	1.64	1.25-1.91	1.67	1.25-2.04
	VIII	13.27	12.20-15.60	13.15	11.70-15.20	1.59	1.31-1.88	1.59	1.34-2.18
	IX	13.45	11.50-21.00	13.51	11.00-21.00	1.57	1.46-2.11	1.57	1.45-1.92
	X	13.76	12.40-15.90	13.79	12.50-15.80	1.40	1.31-1.56	1.38	1.29-1.56
	XI	12.45	11.30-14.40	12.59	11.60-14.50	1.36	1.28-1.50	1.34	1.20-1.51
GENESEE RIVER MOUTH	VIII	14.71	12.80-18.50	14.68	12.70-20.00	2.15	1.47-3.36	2.41	1.44-3.93
	IX	15.40	12.80-21.20	13.15	12.60-14.70	1.55	1.35-2.16	1.36	1.32-1.45

Table 52 (continued). QUALITY INDICATIVE METAL CONCENTRATIONS IN WATER BY CRUISE
(MG/L)

		IRON			
		SURFACE		BOTTOM	
REGION	CRUISE#	OVERALL AVERAGE	RANGE	OVERALL AVERAGE	RANGE
NIAGARA RIVER MOUTH	VI	846	70-2385	861	356-2281
LAKE ONTARIO NEARSHORE	VI	224	118-330	237	141-293
	VIII	113	26-318	99	42-249
	IX	147	24-1125	171	39-1453
	X	280	70-630	336	30-654
	XI	32	3-270	33	2-250
	XII	186	5-780	149	7-770
	XIII	152	2-690	160	4-650
GENESEE RIVER MOUTH	VIII	414	72-1394	647	51-1756
	IX	525	130-1690	229	130-390

Table 53. LAKE ONTARIO CRUISE MEANS AND RANGES AT A 1 METER DEPTH CHLOROPHYLL-A

CRUISE #	MEAN (µG/L)	RANGE (µG/L)
I	3.9	.9 - 10.3
II	6.7	1.6 - 29.3
III	8.3	2.3 - 22.0
IV	8.3	1.4 - 16.5
V	6.5	.01 - 19.4
VI	10.2	.01 - 22.5
VII	9.3	1.3 - 22.9
VIII	4.5	1.2 - 8.0
IX	3.8	.01 - 12.0
X	-	-
XI	4.1	1.4 - 8.1
XII	5.7	1.0 - 11.0
XIII	4.0	1.3 - 16.1

Table 54. VARIOUS AVERAGE SEDIMENT METAL CONCENTRATIONS (MG/G)

REGION	Mg	Fe	Mn	Zn	Cr	Cu	Cd	Pb	Hg	Ni
WESTERN HALF	9,100	39,900	521	226	109	49	5.4	66	2.37	56
EASTERN HALF	7,350	29,200	585	128	55	29	4.7	39	1.32	40
8 KM STATIONS	7,060	40,400	812	167	86	41	4.7	52	1.84	49
4 KM STATIONS	9,800	29,600	484	194	81	38	5.5	54	1.93	48
NIAGARA RIVER MOUTH	12,100	9,700	281	63	27	11	3.8	19	0.18	36
LAKE ONTARIO OVERALL	8,000	34,000	566	172	80	38	4.9	51	1.77	47
GENESEE RIVER MOUTH	5,600	23,000	321	141	39	18	5.0	27	0.29	45

Table 55. VARIOUS AVERAGE SEDIMENT METAL CONCENTRATIONS (MG/G) BY SPECIFIC AREAS

	Mg	Fe	Mn	Zn	Cr	Cu	Cd	Pb	Hg	Ni	AVERAGE DEPTH (M)
NIAGARA RIVER SECTION	5,300	14,200	212	122	40	23	3.2	29	0.92	35	18
ZONE OF HIGH CONCENTRATION	12,000	50,300	642	333	145	67	6.7	94	3.63	67	73
DEEP 8 KM STATIONS	6,100	41,900	730	135	92	40	4.4	46	1.06	47	123
EASTERN MID-LAKE AND DEEP LAKE	7,600	30,100	644	134	56	28	3.9	39	1.37	39	81
ROCHESTER EMBAYMENT	6,200	21,000	283	69	35	20	4.2	28	0.56	36	21

Table 56. STATIONS INVOLVED IN SPECIFIC AREAS

NIAGARA RIVER SECTION	ZONE OF HIGH CONCENTRATION	DEEP 8 KM STATIONS	EASTERN MID-LAKE AND DEEP LAKE	ROCHESTER EMBAYMENT
202	often 203	215	226	240
205	206	218	227	241
208	209	221	229	243
often 203	211	224	230	244
	212		232	245
	214		233	
	217		235	
	220		236	
	223		238	
			239	
			242	